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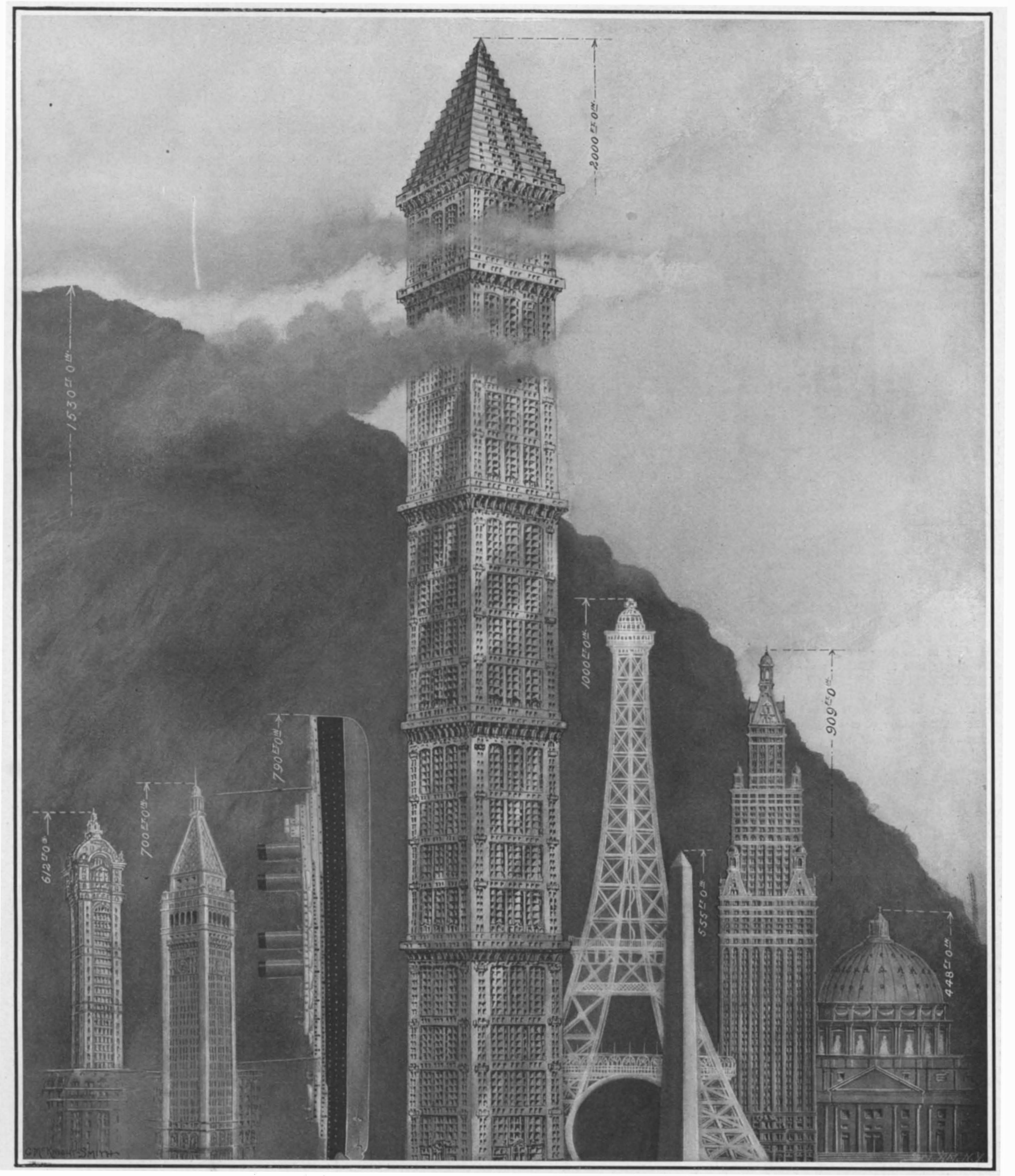
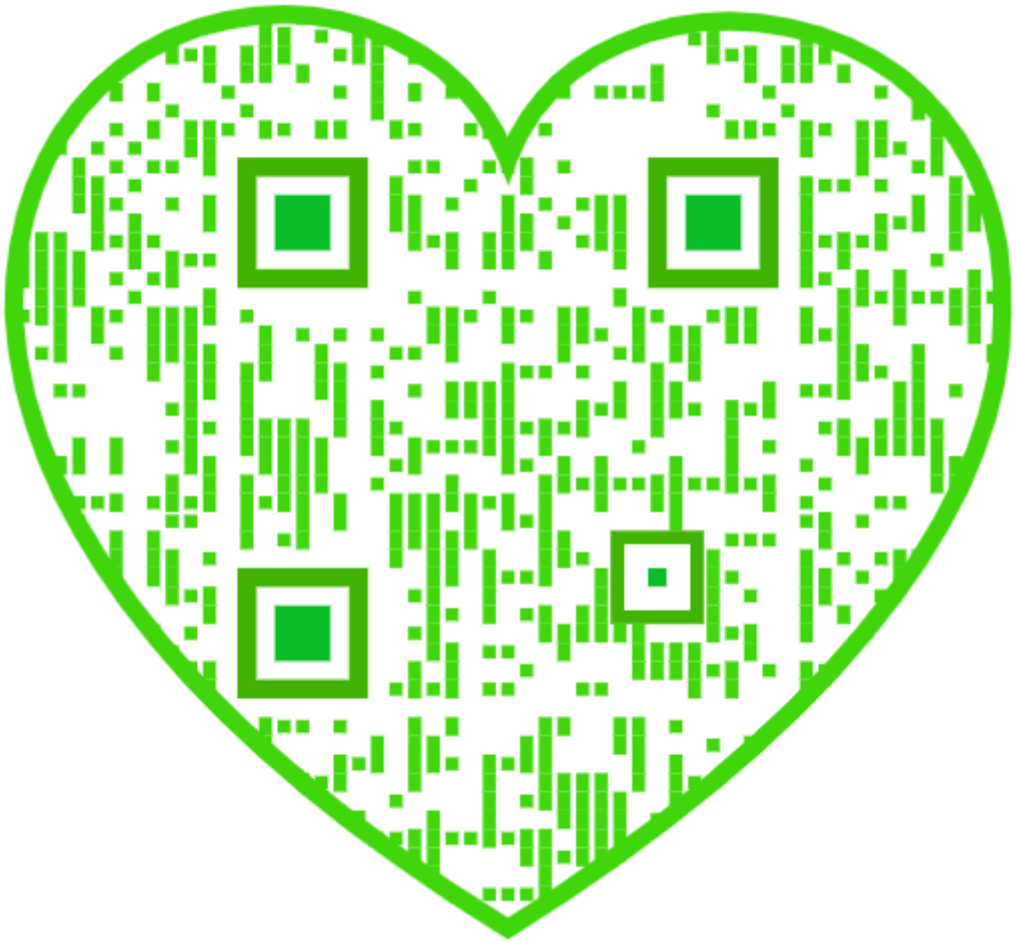


The Building Code of New York City allows a maximum foundation pressure of 15 tons per square foot. Without exceeding this, it would be possible to erect on a lot 200 feet square the huge building shown above. It is 2,000 feet high; weighs 516,500 tons; would cost $60,000,000. The wind pressure would be 6,000 tons. It would take eight times this pressure to overturn the structure.

A 2,000-FOOT BUILDING—THE MAXIMUM POSSIBLE HEIGHT UNDER EXISTING CONDITIONS.—[See page 59.]



SCIENTIFIC AMERICAN

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NEW YORK, SATURDAY, JULY 25, 1908.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE WRECK OF THE WHITE MOUNTAIN EXPRESS.

The wreck of the White Mountain Express on the electric division of the New Haven Railroad was not due to faulty track but to a defect in the design of the electric locomotives. The train, consisting of nine cars, most of them Pullmans, was derailed, through the spreading of the track, when it was running at between fifty and sixty miles an hour through the station at Greenwich, Conn. The track is of the standard type on this road, and consists of 100-pound rails spiked to soft-wood ties, with two spikes to each tie, the ties being laid on a deep bed of broken stone ballast. Immediately east of the station platforms is a 60-foot plate girder bridge, upon the top flanges of which rested the track ties. The first indication of the spreading of the rails was found about 300 feet west of the bridge, where the spikes on the outside of the rail began to show evidence of having been crowded out. The spreading increased until, at a distance of about 30 feet from the bridge, the displacement of the spikes amounted to fully an inch, indicating a spreading of the gage of two inches or more. At this point the locomotives left the track, swept the ties from the bridge, and then traveled for a total distance from the point of derailment of about 1,100 feet before they came to a dead stop. Fortunately for the train, the broken-stone ballast at this point is deep and acted as a brake, and the whole train remained coupled up until the last car had cleared the bridge. The drag of the heavy Pullmans, whose trucks had sunk deeply into the ballast, caused the train to part behind the third car from the front, and the two heavy locomotives, weighing 190 tons, with three cars, ran for 330 feet farther before they stopped. In respect of the small number of casualties and considering the high speed at which the train was running, the wreck is most remarkable, the one death that occurred taking place in the only car which was overturned. That the deaths and injuries were not greater is a tribute to the great strength of the Pullman cars and the vestibule system of connection.

The derailment was undoubtedly due to the heavy lateral swaying motion, or "nosing" as it is called by railroad men, of the two 95-ton electric locomotives which were hauling this train. And just here let it be emphatically asserted, that this disaster is not in the least degree chargeable to the electric installation, as such. That is to say, the heavy side sway of the locomotives is not a defect which is inherently associated with electric traction, since it would have been quite possible, in designing these locomotives, to have eliminated the defect without in the least impairing their hauling power. The side sway is due to the fact that the locomotives have been made altogether too short for steady running. This will be understood when it is stated that, although each of these engines weighs 95 tons, they measure only 36 feet in length, and the body of the locomotive is carried on two four-wheeled trucks whose king-pins are only 14 feet 6 inches apart. This means that the points of support of the heavy upper body of the car are less than 15 feet apart longitudinally. Hence, it is not to be wondered at that when these locomotives are running at express speed, they are subject to severe lateral oscillation, the movement of a double-header when viewed end-on at high speed showing the two locomotives to have a lateral sinuous motion of alarming proportions. The effect has been very marked upon track maintenance. The section foremen complain that it is extremely difficult to keep the rails in proper alinement, the passage of a single double-header express at high speed being sufficient to undo a day's work in bringing the track into alinement. It can readily be understood that, should this side sway synchronize in two locomotives whose combined weight is nearly 200 tons, the side thrust might easily overcome the holding strength of single-spiked rails laid on soft-wood ties. This, we are satisfied, is what occurred in the case under consideration.

This fault in the design of the electric locomotives is due to the failure of the designers to recognize that, in building heavy locomotives for fast service on a steam railroad, entirely different conditions are met from those which obtain on trolley roads. The new locomotives have all the defects of movement which characterized the earlier four-wheeled trolley cars, particularly as regards the tendency to side sway or nosing. But irregularities of movement which may be negligible on a trolley road, with its lighter weights and slower speeds, may easily become dangerous and destructive, where the single unit weighs 100 tons and the speeds run up to 70 miles an hour or over.

At the time of the Brewster wreck on the New York Central Railroad, we pointed out that the electric locomotives would be very much easier on track, and especially at the curves, if they were provided with a four-wheel truck at each end; and those locomotives were longer and much steadier than these on the New Haven system. We are pleased to note that the New York Central locomotives are being remodeled by placing a four-wheeled truck at each end. The necessity for leading trucks is even more imperative in the case of the New Haven locomotives. Either these should be added, the frames being lengthened for the purpose, or the locomotives should be remodeled by placing the present four-wheeled trucks at least 8 feet farther apart, and so increasing the distance between centers to about 22 feet. In our opinion, the locomotives in their present condition are a distinct menace to the safety of travel on the electric zone of that railway. The company, it is true, is rendering its track more secure against spreading by putting flanged tie-plates on every tie, with two spikes on the outside of the rail. But this is an improvement which should be made in any case on any road, whether the service be steam or electric, that can afford to make the change; and it should by no means be considered to obviate the necessity for lengthening the present locomotives; particularly as the small power developed (about 1,000) renders it necessary to use double-headers on all express trains of more than six or seven cars.

THE PROS AND CONS OF THE MARINE GAS ENGINE.

The unverified report recently cabled from England to the effect that the Admiralty is about to order the construction of a battleship propelled by gas engines has greatly stimulated interest in the subject of the marine gas engine. It is probable that the rumor was based upon a paper read about a year ago by Mr. James McKechnie, chief engineer of the Vickers Company, before the Institution of Naval Architects, in which he presented the general plans for a 16,000-ton gas-driven battleship. In view of the increasing interest in this subject, we publish on another page some of the plans and the leading particulars of Mr. McKechnie's paper. Concurrently, we publish in the current issue of the SUPPLEMENT an editorial from our esteemed contemporary, Engineering, in which, after a reference to the paper above referred to, the writer gives a comprehensive survey of the advantages and disadvantages of gas propulsion for ships and arrives at the conclusion that, though the disadvantages are many, they are not by any means insurmountable.

At the present time the British Admiralty has under construction two small gas-engine sets for experimental work, and the adoption of a marine gas-engine installation will not be undertaken until exhaustive trials of the plant have been made both on land and at sea. Although engines of large horse-power are working satisfactorily on land, chiefly in driving electric generators, comparatively few have been installed on ships, and these are of relatively very small horse-power. The leading advantages of installing gas engines of large size on steamships according to our contemporary are as follows: There is a saving of one-third of the space occupied by steam machinery, and a reduction of about one-fourth in the total weights. The greater weight of the steam engine is more than offset by the smaller weight of the gas producers as compared with an equivalent capacity in steam boilers. Speaking broadly, the gas-engine plant has about double the efficiency of a steam-engine plant of the same power, so that not only can a horse-power be developed for one as against two pounds per hour, but it is possible to use a cheaper grade of coal in the producer than in the boiler. Gas producers require much less attendance than boilers. The former, when once they are charged, will continue to make gas for several hours without attention. Moreover, where there is a set of producers, they would be charged in succession, so that a relatively small force could take charge of a large installation of producers, as compared with the large force of stokers necessary or required for a set of boilers of the same capacity. There would be less than one-fourth the amount of ashes to be discharged overboard. There would be no smoke; consequently the considerable space occupied by the uptakes would be vacated for other uses, and the large smokestacks, with the enormous wind resistance which they encounter, would be abolished. This would leave the decks free for the full sweep of the guns; it would remove what is at once a huge object for the enemy's guns, nd a source of great peril because of the poisonous gases emitted if they should be rent asunder by exploding shells. Furthermore, the absence of smoke and lofty funnels would enable a ship to get well within range before being detected. Finally, the gas engine with its many cylinders would be less liable to complete disablement, since each cylinder is a gas engine complete in itself; and, should several upon a shaft break down, as long as there was a single cylinder left in working order the propeller could be operated.

Chief among the disadvantages, according to the writer, is the very high temperature that, is inseparable from the cylinders of large size. But there are many ways in which this excessive temperature may be reduced, such as giving the engine a long stroke, diluting the charge with air, increasing the volume of circulating water in the jackets or pistons, or injecting water into the cylinder during combustion. Valves of such large size as would be required could be water jacketed, and the speed of the hot gas through the valves can be reduced by making them double-seated. When gas engines are designed especially for marine work, they will be provided with thin water-cooled pistons; they will be double-acting and will be fitted with crossheads and slides similar to those used upon steam engines. The difficulties in making a gas engine reversible have been due to the use of the usual revolving-cam gear; but on large engines oscillating cams, operated by the Stevenson link motion, or one of the Joy type can be used, and handled by compressed air, when the size of the engine renders this necessary. The disadvantage of the marine gas engine due to its want of flexibility in the rate of revolution can be met either by cutting off the gas supply to one or more cylinders, building the engine in two or more units capable of being quickly connected up or disconnected, or applying the power on three or more shafts.

A mechanical disadvantage for marine work is the uneven turning moment, especially on the four-stroke cycle; and although this is more satisfactory on the two-stroke cycle, in the latter case, twice the amount of hot gas must pass through the exhaust valve in a given time. Another mechanical difficulty is that of governing the engines in rough weather, when the propeller may be lifted from the water and racing occur. Our contemporary suggests that either some form of high-speed centrifugal governor acting on the gas supply, some means of relieving the pressure in the cylinders, or cutting out the ignition—or a combination of these methods—should be able to meet the difficulty. With regard to the difficult problem of the exhaust, it is suggested that some form of surface condenser in combination with the injection of part of the cooling water into the exhaust pipe would meet the case, silence being secured by discharging the gases below the surface of the water.

THE FIFTH ANNUAL AUTOMOBILE TOUR FOR THE GLIDDEN TROPHY.

The Glidden tour this year is over a 1,700-mile course, extending from Buffalo to Pittsburg, thence north to Albany, N. Y., east to Boston, north to the Rangely Lakes in Maine, and then west through the White Mountain district, across Vermont to Saratoga. The contestants are divided into teams of three cars each, these teams being entered by different automobile clubs. Each car is credited with a thousand points at the start, and points are deducted for failure to make the schedule or for repairs made to the car. The rules are stricter than heretofore, and the tour, instead of being a pleasure jaunt, is a thorough reliability contest, with an official observer on every car.

In the first day's run of 117.4 miles, from Buffalo, N. Y., to Cambridge Springs, Pa., there were thirty contesting cars for the Glidden trophy and thirteen for the Hower trophy for runabouts. In addition to these there were ten press and official cars. A speed of 20 miles an hour was maintained with little difficulty. The only car to meet with a serious mishap was a Gearless 6-cylinder runabout, which skidded and collided with a telegraph pole. The car was so badly damaged that it was obliged to drop out, although, fortunately, the occupants of the runabout were not injured. Most of the touring cars carried but four people, while the runabouts, as a rule, carried three.

The second day's run of 122½ miles, from Cambridge Springs to Pittsburg, was carried through at the rate of 19½ miles an hour—a rather fast average speed in view of the short steep hills and rough country roads that had to be traversed for fully half the distance. A Garford touring car skidded and broke a

wheel, an Oakland burned out a connecting rod bearing, and the Gyroscope runabout had trouble with overheating.

The third day's run, from Pittsburg to Bedford Springs, Pa., despite the fact that it was over much rougher roads than were traversed last year, and also that it was carried out at an average of 17 miles an hour, resulted with the disablement of but one machine—an Overland runabout—which broke its axle shortly after leaving Pittsburg. A leaky carbureter near the magneto of the Stoddard-Dayton runabout, No. 109, produced a fire which cost this car 168 points. Another Overland runabout was 9 minutes behind its schedule. The Gyroscope runabout did not arrive until 1 A. M. There were several fast runs to make up for lost time. The distance traversed was 106.4 miles. This day's run was the hardest, as two mountain ranges had to be crossed. A second Garford car broke one of the drive shafts of its floating rear axle, but Hurlburt, the driver, succeeded in removing the broken shaft and replacing a new one in an hour and a quarter, and in afterward making up this time, which was remarkable considering the rough roads.

The fourth day's run of 107.3 miles, from Bedford Springs to Harrisburg, for one-third of the distance at least was a repetition of that of the day before. There were numerous water breaks for the cars to bump over, and several long climbs through stretches of heavy sand. An average speed of 18 miles an hour was required. Two more teams lost points. A Franklin car stopped to weld a new spring leaf at a wayside blacksmith's shop, and as a result arrived late and lost 61 points. The Selden car, which also had trouble with its springs, was penalized for being late. A Franklin runabout broke several of its spring leaves, and was penalized 181 points. A Moline runabout cracked a cylinder, and lost 51 points.

At Boston (960 miles) the perfect-score cars remaining were 3 Pierce Arrows, 3 Peerless, 3 Marmons, 2 Studebakers, 2 Haynes, 2 Franklins, a Gaeth, Oldsmobile, Premier, Ranier, Reo, and Thomas. There were also 2 Pierce, 2 Stoddard-Dayton, and one Premier runabout in the perfect-score class, as well as 2 Stevens-Duryea non-contesting touring cars.

SOME RESULTS FROM THE 1908 TOTAL SOLAR ECLIPSE.

BY PROF. S. A. MITCHELL, COLUMBIA UNIVERSITY.

The wonderful progress of astronomy during the last half century is nowhere better illustrated than in the attitude of astronomers toward observations at a total eclipse of the sun. To those of us who have been fortunate enough to view an eclipse, to see the matchless beauty of the corona with here and there a glimpse of a rosy red flame, it seems strange that up to 1842 we have practically no mention of the prominences, which at the present day are studied even without the help of an eclipse. The red flames which in the eclipse of that year were so bright as to be seen by the populace were greeted by them with shouts of "Long live the astronomers" for giving the beautiful spectacle to delight their eyes. But the astronomers were as much mystified over their appearance as anyone else; some thought the flames were caused by a freak of our own atmosphere, others that they were caused by diffraction around the moon, while still others thought they belonged to the sun. At the eclipse of 1860 photography was first used with anything like success, and by its aid it was shown that the red flames were part of the solar furnace, because the moon covered up the flames on one side and uncovered them on the other as the moon passed across in front of the sun.

Before the next eclipse the spectroscope came to be understood. It may be said that modern scientific observations of eclipses began with that of 1868, only forty years ago! But what an array of magnificent discoveries! If you take the sum total of the time spent in observing eclipses, and count the precious minutes one by one that have been at the disposal of the astronomers, we find somewhat less than one hundred minutes devoted to actual observation in the last forty years. But what a wonderful list of problems solved concerning the sun! Listen to a short enumeration of them!

In 1868 the famous astronomer Janssen of France went to far-off India to see the eclipse, and his eyes were the first to see the spectrum of a prominence. This spectrum consisted of a series of bright lines whose position told in unmistakable terms that the red flames were real tongues of fire, masses of hydrogen gas shooting up to great distances above the sun. In fact the lines of the spectrum were so bright that he tried to find them next day without an eclipse. His success, which was shared by Sir Norman Lockyer of England, made the study of prominences an everyday matter. At the eclipse of 1869, Harkness, of the Naval Observatory, Washington, discovered helium in the sun, a metal of great interest to the scientist. It was not till 1895 that helium was discovered in small quantities on the earth by the great English chemist, Ramsay. Before the eclipse of 1870, Young of Princeton foretold that if one should look sharply with a spectroscope at the instant that the moon covered up the entire surface of the sun a beautiful spectacle would appear known as the "flash spectrum." He himself went to Spain and was there rewarded by being the first to see the phenomenon he had predicted.

But what is the "flash spectrum"? And what does it tell about the sun? The ordinary spectrum of the sun consists of a bright ribbon of light crossed by thousands of fine dark lines, known by the name of their discoverer as Fraunhofer lines. If the sun had no surrounding shell of vapors the spectrum would consist of all colors of the rainbow but with no breaks or dark lines in it. These lines, which were a great enigma to astronomers from their discovery by Fraunhofer in 1814 to their explanation by Kirchhoff in 1859, show that the intensely brilliant sun is surrounded by a shallow layer of relatively cool gases which absorb the solar light and leave gaps in its spectrum. The moon as it crosses the face of the sun, cutting off its light and causing the eclipse, does so gradually. At the instant that the body of the sun is covered up totality begins, the corona appears, the most gorgeous of all natural phenomena. At this instant the moon, which has covered up the sun's surface, has not hidden the sun's atmosphere of gases. These vapors, though cooler than the sun, are nevertheless at an exceedingly high temperature, and the spectroscope and the photographic plate together make them tell their story, a wireless message from the sun. As these solar vapors are intensely hot their spectrum consists of bright lines. But what a change there has been in the spectrum, in a flash, in the twinkling of an eye! As long as even a small edge of the sun is visible its light is so overpowering that the ordinary Fraunhofer spectrum is seen. But at the instant of totality the edge of the sun disappears and the spectrum is changed from a dark line spectrum to one consisting of bright lines. The change is made with such rapidity, the bright line spectrum flashes out so suddenly that it was called by Young, its discoverer, the "flash spectrum."

But what is the story concerning the beautiful corona that can be seen only during the few minutes that the sun is totally eclipsed? The prominences, by a peculiar use of the spectroscope, are rendered visible without waiting for an eclipse; might not the spectroscope make the corona visible likewise? Much thought and attention have been put on this problem and many attempts have been made to see and photograph the corona without an eclipse, but all have failed. The sun's light is so intense that even the smallest edge of it gives a more powerful light than the corona and obliterates it. Astronomers are keenly interested in the crown of glory round the sun, and are willing to travel long distances and spend months of their time in the attempt to unravel some of its mysteries. (The writer in 1901 went half way round the world to the Dutch East Indies in order to make observations through a space of time of five short minutes.)

Prof. C. G. Abbot, director of the observatory of the Smithsonian Institution, has just published a very valuable contribution to astronomical knowledge, giving his results at the latest total eclipse on January 3, 1908. The path within which a total eclipse of the sun could be seen has crossed some inaccessible parts of the globe since 1900, the last total eclipse visible in the United States. In 1901 it became necessary to travel to Sumatra to observe the eclipse, in 1905 to Spain, in 1907 to Siberia in mid-winter! The eclipse track on January 3, 1908, crossed land only over a few small islands in the middle of the South Pacific, and one of these, Flint Island, lying in latitude 11 deg. south, longitude 152 deg. west, was occupied by a party comprising Prof. Abbot of the Smithsonian Institution and astronomers under Prof. Campbell, director of the Lick Observatory, California. This island, a coral reef two and a half miles long by a half mile wide, and only 24 feet above sea level at the highest point, was the objective point of English-speaking people from England, Australia, New Zealand, Tahiti, and the United States, drawn there for the purpose of observing the sun for about one hundred seconds of time! And how nearly the whole expedition was to a dismal failure! The total eclipse was to begin January 3, at 11:15 A. M. From 11:08 to 11:14 rain was falling fast, and at the station occupied by the Smithsonian party the sun became clear of the cloud only 15 seconds before totality! What a close shave it was! Astronomers after months of work and preparation must be ready to face disappointment from cloudy weather on the important day of the eclipse. In 1901 Prof. Abbot carried his very sensitive apparatus to Sweden only to be rewarded with a view of a dense bank of clouds, through which never a ray of the sun penetrated! It was a close call in 1908, but the clouds cleared away in time and some splendid scientific work resulted.

The party from the Lick Observatory were attempting a three-fold line of work: (1) Photographing the corona on a large scale with a camera forty feet long, (2) photographing the spectrum of the sun's atmosphere, and (3) searching for some new members of the solar system, between Mercury and the sun—intra-mercurial planets as they have been called. All these lines of work were carried on with the aid of the photographic plate, and though somewhat hampered by thin clouds, the whole work was extremely successful.

The examination of the intra-mercurial plates is not yet completely finished, but it seems almost certain that no new planets will be discovered; and, accordingly, astronomers must seek some new explanation of the mysterious behavior of the perihelion of Mercury, whose motion has apparently not followed the known law of gravitation.

Prof. Abbot was attempting to measure in final way the brightness of the corona, comparing it with the moon, the sun, and the illumination of the sky in order to find out how the corona derives its light and how it is possible for it to stretch out ten millions of miles from the sun and shine with a beauty not anywhere equaled in creation. Some astronomers suppose the radiation of the inner corona to be principally reflected solar light; others suppose it due principally to the incandescence of particles heated by reason of their nearness to the sun, while still others imagine the corona to be somewhat of an electro-magnetic manifestation similar to the aurora. Which is right? Or is there something of truth in all three? To test these hypotheses, it is necessary to measure the radiation of the corona and compare it with that from other sources. This Prof. Abbot did by the aid of the bolometer joined up with a delicate galvanometer, the whole forming an apparatus for measuring excessively small quantities of heat. The bolometer used at the eclipse observations consisted of two thin blackened platinum strips 8 millimeters long and 0.7 millimeter wide and of 0.5 ohm resistance. These formed two arms of a Wheatstone bridge, and the difference in resistance of the two strips was measured by a galvanometer which can be made very sensitive. If one of the platinum strips of the bolometer becomes heated more than the other the resistance offered to the passage of a current of electricity through the strip is increased, and this change in the *statu quo* is shown by the deflection of the galvanometer needle, the amount of deflection being read off from a beam of light reflected on a millimeter scale. The galvanometer used had a total resistance of 1.5 ohms, composed of 12 coils, all connected in series. The needle system, of no less than 30 needles, carried a mirror 1 millimeter by 1.2 millimeters, and the whole weighed complete 0.011 gramme each, or about one-sixth of a grain! Could anything more delicate be conceived? During the eclipse, installed in a temporary hut, the whole apparatus worked beautifully. One millimeter deflection on the scale indicated that one bolometer strip had a higher temperature than the other of about 0.00001 deg. C. Rather a delicate thermometer! But this is far from the most sensitive condition possible. In Washington, while attempting to measure the heat of stars, Prof. Abbot and the writer succeeded in getting a similar but more sensitive apparatus capable of measuring a rise of temperature of 0.00000001 deg. C., sufficiently delicate to detect the heat of an ordinary candle at the distance of 5 miles!

This imperfect description of the Smithsonian apparatus will give some idea of the delicate and difficult task of measuring the heat of the corona, and of tracing its energy at different distances from the sun's edge. Without at the present time going further into the details of the apparatus, let there here be tabulated the results, where corona, etc., is compared with the brightness of the sun represented by the large number 10,000,000:

Sun near zenith (Flint Island)	10,000,000
Sky 20 deg. from sun (Flint Island)	140
Sky distant from sun (Flint Island)	31
Sky, average (Flint Island)	62
Sky, average (Mount Wilson, Col., elevation about 5,000 feet)	15
Corona 1′.5 from sun's limb	13
Corona 4′.0 from sun's limb	4
Moon about 50 deg. from zenith (Flint Island)	12

A comparison of the above numbers gives some very interesting food for thought. It is seen that the corona 1′.5 from the sun's edge (the diameter of the sun is about 32′) is about as bright as the full moon, but the brightness of the corona very quickly falls off, so that at 4′ from the sun's edge corona is only one-third as bright as the moon. The sun's face is a million times brighter than the corona 2′, or one-sixteenth the sun's diameter, away from the sun. Also when we recall the extreme brightness of the sky within a single degree of the sun and contrast it with the sky brightness 20 deg. away and then see that the corona is less than one-tenth that of the sky 20 deg. distant, it is readily seen that the proposal to observe the corona without an eclipse is indeed an unpromising and hopeless task.

That the corona derives its light from negatively electrified particles shot off from the sun, an electromagnetic action similar to the aurora, has been a very interesting and attractive hypothesis, but Prof. Abbot's measures cause him to modify this theory, for in his judgment the light of the corona is merely due to ordinary sun rays reflected by the small particles of matter near the sun.

HOW DOES AN EGG DEVELOP INTO AN ANIMAL?

SIMPLE ACCOUNT OF SOME RECENT DISCOVERIES.

BY CHARLES R. STOCKARD, M.SC., PH.D., CORNELL UNIVERSITY MEDICAL COLLEGE, NEW YORK.

Omne vivum ex ovo! All life from the egg. This famous aphorism, generally attributed to William Harvey, the immortal discoverer of the circulation of the blood, suggests the query: How? Since all higher animal life comes from the egg, then what question should be of so deep an interest to living beings like ourselves, as: How does the complex animal arise from its seemingly simple beginning in the egg? Why does the frog's egg always develop into a frog instead of a fish or a lizard? Which was first—the egg or the hen? What power, mechanical or vitalistic, does the bird's egg contain which causes the living chick to break forth from the shell after subjection for a limited period to a certain temperature? See now what answers the study of developing eggs may give to these questions, some of which at first thought seem more amusing than serious.

Since the days of William Harvey it has been found that the egg is really a single cell, and that all animal bodies are composed of collections of many cells. A cell then may be described as the vital unit; it is usually surrounded by a membrane-like wall, and consists of a body or substance with a central generally dense mass called the nucleus or kernel. Cells as a rule are microscopic in size, though some cells are easily visible to the unaided eye. The egg then is such a cell, and from this egg our task is to produce the frog or the hen.

The frog's egg is a small sphere about as large as a squirrel-shot surrounded by a mass of jelly-like material somewhat similar to the white of a hen's egg. The eggs are laid in small lakes and pools of water. To develop into a frog, the spherical egg first becomes divided into two halves, which stick close together. Each half is a complete cell. (Fig. 1 illustrates the complex mechanism concerned in cell division.) A second division then occurs, and the egg becomes four-celled; a third division splits each of these four cells, and we have an eight-celled egg. This process of cell division continues until the egg is divided into hundreds of little parts, each a cell. During this period a cavity is formed in the center of the cell mass, so that the entire egg may now be likened to a hollow rubber ball, the many cells forming its wall. A folding process then begins, as if one pushed in the wall at a certain place, thus converting the hollow ball into a two-layered sac. (See Fig. 2.) From this two-layered sac by a continuation of cell division and folding processes the form of the tadpole is gradually molded, and at last it swims forth, the common little black object that darts to and fro in the pools during late spring. (See Fig. 3.) After living for some time as a fish-like animal breathing with gills, the tadpole becomes more ambitious, and four little legs begin to bud forth and lungs develop. Finally the legs grow long, the lungs become efficient respiratory organs, the gills are lost, and the young frog leaps forth upon the dry land a finished marvel from the hands of that great prestidigitator, Nature. All animals from those very low in the scale up to the highest develop in a fashion strikingly

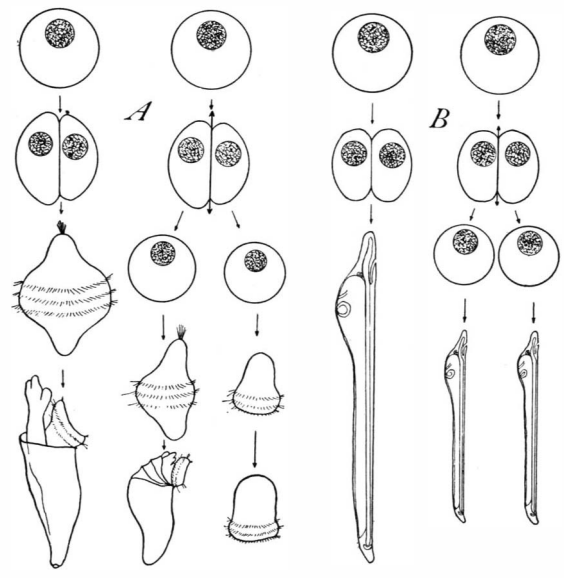


Fig. 4.—Diagrams illustrating the results when the first two cells of the developing egg are cut completely apart. *A*, Snail's egg, to the left developing normally, to the right one of the two separated cells develops into the head region only, and the other into the body portion. *B*, The lancelet egg, to the left developing normally, to the right each of the two separated cells develops into a perfect animal though a dwarf in size.

similar to that briefly described for the frog. Usually, however, the egg develops continuously or directly into the finished animal, so that there is no tadpole or larval stage. From the hen's egg hatches the fully-finished chick, exactly like its parents in general body form.

Many of the earlier students of animal development thought that the embryo, or young animal, was fully formed in the egg. They claimed to see the miniature chick in the egg of the hen. To them development from the egg was merely a process of growth and unfolding, as the bud grows and expands into the flower. The eminent Swiss naturalist Bonnet was the great champion of this idea. Such a doctrine seems strangely naïve to us of to-day, but we shall later see the glimmer of truth that it reflects when placed before the mirror of experiment. A young German, Wolff, in 1759 was the first, however, to scientifically prove that this idea of preformation in the egg was incorrect in its old form. He showed that the chick was not already formed, but that it developed step by step from a simple beginning into a more and more complex organism. Each stage in the development followed and resulted from a preceding stage; development was "epigenetic." Now keeping in mind the fact that the egg is a single cell, and that the animal consists of thousands of cells all derived from this one egg, a fact unknown to Bonnet and Wolff, we may attack the question whether or not the animal is preformed in the egg with modern experimental methods. If the animal is really already formed, then when the egg divides and gives rise to two cells, each of these cells must represent a given portion of the animal's body—they may be, we will say, its right and left halves. When one of these cells is artificially injured or killed, one-half of the body should be absent, provided that the other cell is capable of continuing its development alone. Better, if we cut the first two cells apart, each should develop into a piece or a half of the animal. Looking now at the other side of the question, let us suppose that the animal is not preformed in the egg, but develops step by step from a simple beginning into the complex end product. We should then find, on separating or cutting apart the first two cells in the division of the egg, that two embryos would result, since each moiety might have the power to develop as a whole egg. (See Fig. 4, illustrating the probable results in each case.)

Much to the credit of present-day students of animal development, such experiments have been performed upon many different kinds of eggs, with results of most fascinating interest. The eggs of the sea-urchin, starfish, jelly-fish, and amphioxus, a small animal closely related to the vertebrates, have been operated upon as follows: When these eggs have divided into two cells, if the cells are cut apart each one develops into an embryo in all respects normal, except that it is about one-half the usual size. If when the egg has divided into the four-cell condition, the four cells be separated or broken apart, then we get four dwarf embryos, each one-quarter normal in size. In the case of the jelly-fish we may perform such an experiment on the egg which has divided into sixteen cells; when the sixteen cells are separated one from the other, we get as many embryonic dwarfs as there were cells. This is an experiment of vast importance, since (see what has been accomplished) the experimenter has taken an egg which would have normally produced only one individual animal, and from that single egg he has caused to be produced two, four, eight, or even sixteen individuals. Some eggs may be cut into pieces

Fig. 1.—Microphotographs of eggs showing the mechanism concerned in dividing one cell into two. Every black rod seen on the spindle-like arrangement is split into two equal parts, one part going to each of the two new cells. Magnified.

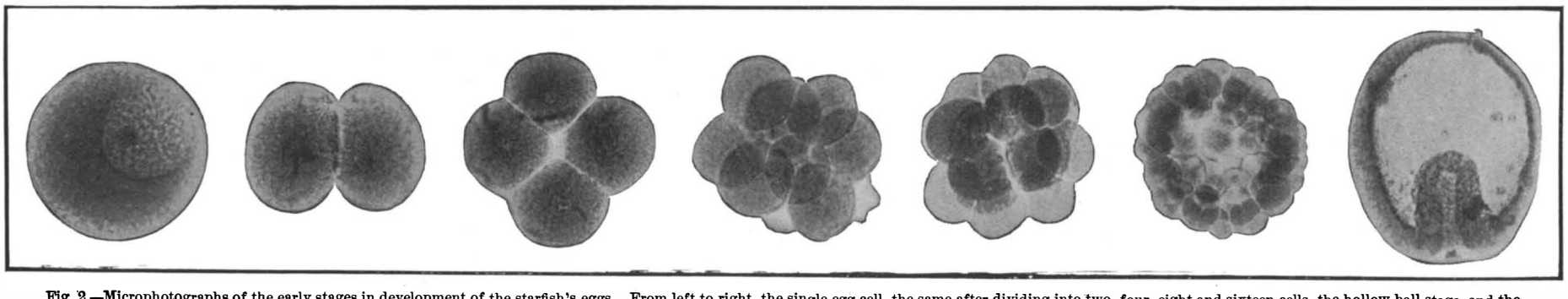


Fig. 2.—Microphotographs of the early stages in development of the starfish's eggs. From left to right, the single egg cell, the same after dividing into two, four, eight and sixteen cells, the hollow ball stage, and the hollow ball becoming changed into a two-layered sac by the inpushing of its wall. Magnified.

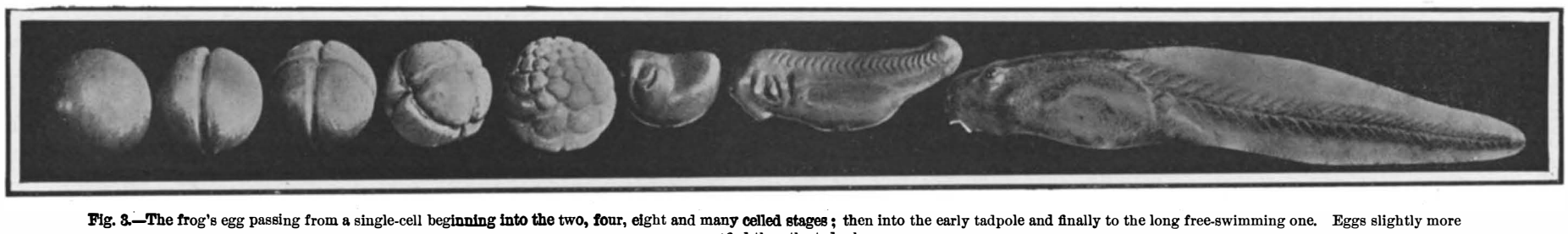


Fig. 3.—The frog's egg passing from a single-cell beginning into the two, four, eight and many celled stages; then into the early tadpole and finally to the long free-swimming one. Eggs slightly more magnified than the tadpoles.

Photographs by Dr. L. Jacques.

before they have started to divide, and the several pieces made to develop into embryos.

The separation or breaking apart of the cells of dividing eggs probably takes place at times independent of the experimenter. When such a thing occurs, we get twins developing from what would have given rise to a single individual. It is well known that twins occasionally resemble one another to such a degree that they are indistinguishable (one may recall the principals in Shakespeare's "Comedy of Errors"). Such cases are called duplicate twins, while other twins may resemble one another to no greater degree than do any two offspring from the same parents; these are, therefore, called fraternal twins. This latter class result from two independent eggs, which merely chance to develop at the same time. As intimated, the duplicate twins are likely due to the development of the separated cells of one egg. This idea is substantiated by the occurrence among many kinds of animals of what are known as double monsters, or Siamese twins, two individuals with their bodies united or grown together. (See Fig. 5, showing Siamese twin chicken embryos.) When the first two cells from the egg are in some way pushed unusually far apart but not entirely separated, they develop each into a complete embryo, although the two embryos are joined together. Such double embryos may be artificially made to develop from the eggs of the starfish, sea-urchin, frog, and many other animals.

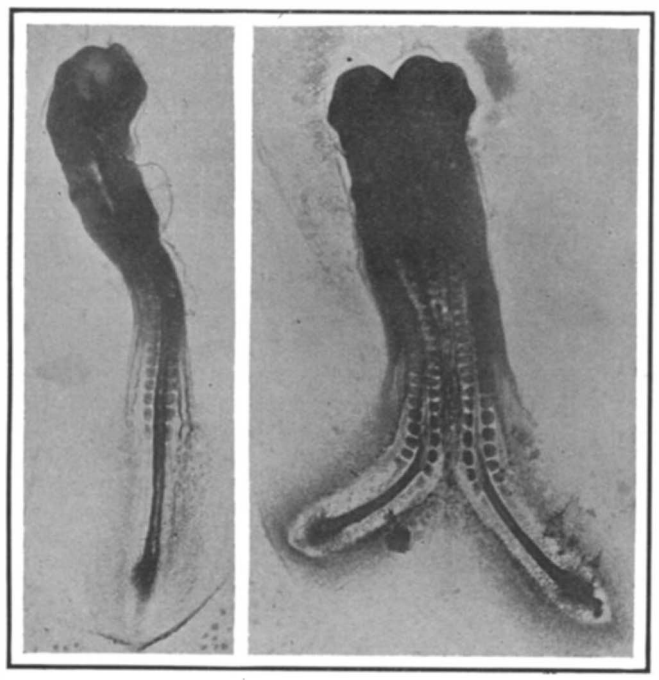


Fig. 5.—Photographs of chicken embryos. The left one normal, and on the right are "Siamese twins," the two individuals lying almost parallel.

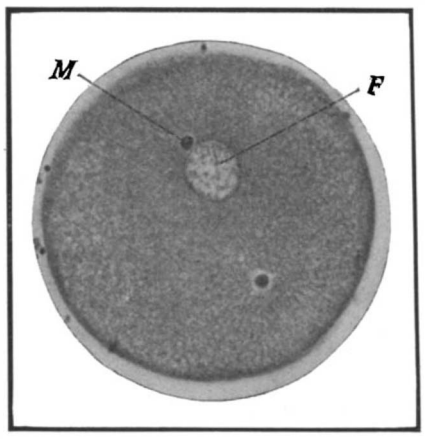


Fig. 7.—Microphotograph of the egg of a sea-urchin showing the approach and fusion of the male and female elements. *M*, male; *F*, female pronucleus. Magnified 800 diameters.

Fig. 8.—Frog with many hind legs, produced by injuring the hip girdle of the tadpole.

So far then it appears that the animal is not at all preformed or contained in miniature in the egg, but let us not reach too hasty conclusions. One must examine, as leading American students of development have done, a number of other animals, and he will find strangely contradictory results. When the cells of the dividing eggs of certain worms or those of some sea-snails are separated, we do not find complete embryos resulting from the development of the isolated cells. The separated cells develop into parts of embryos, certain cells forming definite portions. In one of the snails, for example, some cells are destined to develop into the posterior body region, thus giving headless individuals, while other cells develop into the head parts, the body regions being absent. We may picture headless bodies and bodyless heads swimming frantically about in the water. Here then we do seem to find a preformation, or at any rate a prelocalization of the parts of the embryo, since in the early egg one area or spot is destined to give a definite part or portion of the future animal. Strange as it may seem, certain of these areas are visible in the egg before embryonic development has begun. Owing to the presence of variously-colored substances in some eggs, one is enabled to remove areas which represent future portions of the animal, just as though we picked the future eye or brain out of the egg. This may be called the modern idea of preformation; and although it does not mean that the embryo actually exists in miniature, it nevertheless holds that a great complexity does exist in some eggs, and although the animal may not be preformed, it is doubtless mapped out within the egg substance.

It is surprising to find that the development of the frog's egg is greatly affected by its position, thus indicating the plasticity of its preformation. The egg naturally floats in a definite manner with the region containing the heavy yolk turned down and the opposite lighter region pointing upward. After the egg has divided into two cells, if one is killed by a hot electric needle, the other cell continues development, but forms only one-half of the animal. Should the egg, however, be placed in an inverted position with the heavy yolk up instead of down, then either of the first two cells will form an entire animal instead of only a half. A German experimenter by fastening the frog's eggs upside down obtained double animals in various associations, each animal being a whole one. (See Fig. 6, illustrating such an experiment.)

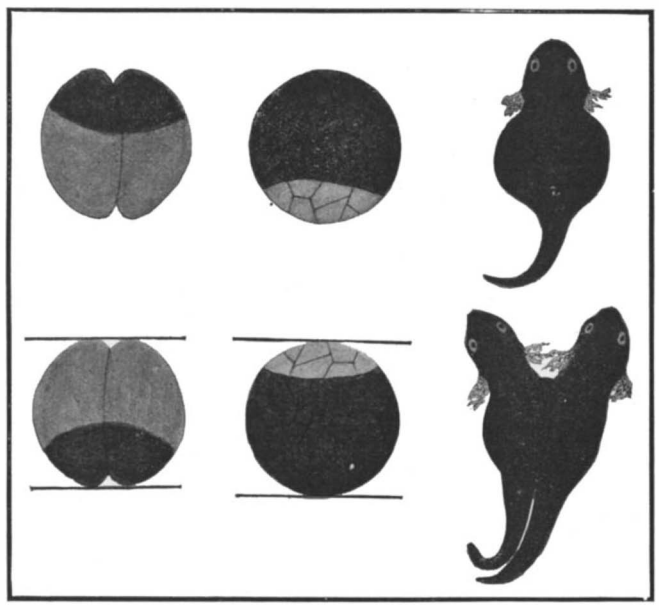


Fig. 6.—Illustrating the effect of position on the developing frog's egg. The top row of figures are normal, the bottom row indicates the result when the egg is fastened in an inverted position; double embryos are formed.

Eggs at the beginning of development may be whirled in a centrifuge (a machine revolving many hundred times per minute) which will cause their heavier substances to accumulate in one part and the lighter materials to be forced to an opposite position. This instrument thus enables one to disarrange the contents or parts of the egg. After being subjected to such treatment some eggs are still able to develop normally, while others as the frog's egg form more or less peculiar embryos. If, however, the animal had been already laid down in miniature in the egg, then we might have expected the centrifuging to shake up its parts, and cause legs and wings to exchange places or other strange and grotesque arrangements to occur.

We may now conclude our consideration of whether or not the animal is preformed in miniature in the egg as follows: There is no egg which at the beginning of its development shows any indication of a ready-formed animal, although in many eggs certain regions or parts are definitely laid out and destined to form given portions of the future animal. During development all eggs gradually become more and more divided up into parts which are to give certain organs of the animal. The German investigator Driesch has stated that the egg differs from a machine in that its parts are independent, some of which may be removed and the whole readjust itself and continue to act (develop) while the parts of a machine are mutually interdependent, so that the whole must stop if any part be removed. We have seen that this statement will not apply to all eggs even at early stages, and will probably not hold for any egg during all stages of development. Why in the egg of the snail were the first two cells unable to readjust themselves and form entire animals instead of only partial ones?

PECULIAR NEW EXPERIMENTS.

Most eggs to begin development must contain an element derived from the male of the species. The offspring is the product of two parents, and possesses two sets of qualities, the maternal and the paternal. To quote Huxley, that master of clear expression: "It is conceivable, and indeed probable, that every part of the adult contains molecules derived both from the male and from the female parent; and that, regarded as a mass of molecules, the entire organism may be compared to a web of which the warp is derived from the female and the woof from the male." (Fig. 7 shows photographs of eggs in which the male and female elements are uniting to begin development.)

Queer as it may seem, there are some insects and other animals whose eggs are capable of developing independently of the male element. Thus the offspring has only one parent, the mother. For example, the queen bee lays eggs that are fertilized, or contain the male element, and also unfertilized eggs containing only the maternal elements. It is of interest to find that the fertilized eggs all develop into females, either workers or new queens, while the unfertilized eggs containing no paternal element form the male bee or drone. Other insects, as the aphides, or plant lice, have a long series of generations in which no males occur alternating with other generations in which males are produced. Here then there are times when both male and female offsprings are derived from eggs lacking the male element, or from the mother alone.

Experimenters have taken the eggs of certain animals which normally require fertilization, and artificially caused them to develop independent of the male element. The eggs of the sea-urchin, starfish, worms, and to a limited degree even the frog have been made to develop without the male element by merely treating them with weak chemical solutions, shaking, and in a number of other ways. This is not so miraculous as it might have seemed, had we not known of animals like the insects mentioned above which usually reproduce in this manner.

Experiments of peculiar interest have been performed in transplanting organs from one embryo to another, as well as in moving organs to strange new positions on the animal's body. The developing eye of a frog may be removed from its normal place to the back of the animal's head, and thus given an eye on its neck. So one realizes the possibility of animals developing the wonderful power of seeing behind them, or of having eyes in the back of their heads. A part of the eye (the early crystalline lens) may be cut away, and "skin" from the ventral surface of an embryo of another species of frog may be placed over the eye and made to form the missing part.

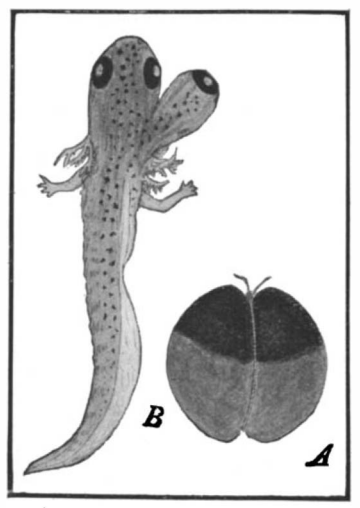


Fig. 9.—A salamander egg. *A*, the two-cell stage constricted by a fiber. *B*, A peculiar double-headed embryo resulting from an egg thus constricted.

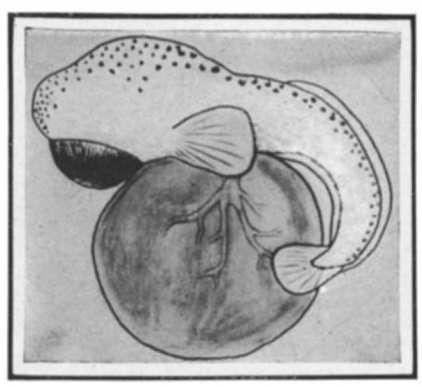


Fig. 10.—A fish with one large eye in the middle of its face (Cyclops defect) caused by allowing the eggs to develop in solutions of magnesium chloride.

When certain portions of the hip-bone of a tadpole are scratched or injured, extra legs are formed from these places of injury, and so the tadpole may give rise to a frog with as many as six hind-legs. A most brilliant opportunity for dealers in frogs' legs! (Fig. 8 shows a photograph of one of these many-legged frogs.)

The eggs of a salamander when in the two-celled stage have been tied or constricted with a thread. (Fig. 9A.). Such eggs develop into animals with two heads, and peculiar enough in some cases one of the heads has only a single eye in the middle of its face. (Fig. 9B.) This median eye, from its resemblance to

the eye of the monstrous Cyclops of mythology, is termed a cyclopean eye. By treating the developing eggs of a fish with particular chemical solutions, a large number of fish embryos with the cyclopean eye have been produced. (Fig. 10.) These young fish with their large single eye present a most peculiar appearance.

Fish eggs as a rule develop in water, yet the eggs of some fishes may be removed from the water and made to continue their development in a humid atmosphere. The eggs are unable to hatch while out of water, and may be kept living in such a condition three times as long as the usual hatching period. At any time, however, after the end of this period, when some of the eggs are placed in water they begin within a few minutes to hatch, the young fish rapidly breaking through the membranes and swimming away.

Chemical solutions influence embryos to form in peculiar fashions, and probably on final analysis each chemical element will be found to cause a specific embryo from a given egg. The element lithium induces characteristic embryos to develop from the eggs of the sea-urchin, and probably the frog and fish. It is likely that each species of animal differs from all others on account of the particular chemical composition of the egg from which it develops. Thus the frog's egg develops only into a frog and not into a fish or a lizard. If the chemical composition of the frog's egg could be made identical with that of a lizard egg, then a lizard might arise from the egg of a frog. Some sudden changes in evolution are thought to take place in the egg. Thus the composition of the egg may be affected, and the young animal resulting from this egg may differ in appearance from its parents. We may suppose, if this be true, that the egg was before the hen, and the original animal that produced the egg may not have been strikingly like the hen.

But what is the use of all this expenditure of mental and physical labor? What good is to be derived from such experimentation on sea-urchins, fishes, and frogs? Such questions have no doubt presented themselves to the practical reader before this, and to one unfamiliar with this somewhat walled-in field of science the questions are admissible. Through the study of animal development, embryology, we are enabled to understand more clearly the complex structure or anatomy of the finished product, the adult man. In the practice of medicine, and particularly surgery, such a thorough understanding is of far-reaching importance. Certain of the deformities in man and other animals we now know to result from imperfect development—harelip, cleft-palate, spina-bifida, cyclopean eye, various heart defects, and many more. The monstrosities produced in the experiments above mentioned oftentimes occur from unknown causes, and their artificial production enables one to better understand the processes involved in their occurrence, and thus casts the first rays of light along that merciful road leading to prevention and cure.

Animals often lose their limbs and other parts through accident, and certain of them have the wonderful capacity of replacing the lost parts by growing new ones. The growth of such new parts seems to follow rules strikingly similar to those controlling embryonic growth, and we look forward to a bright future when animals now unable to replace a lost arm or leg may be caused to accomplish such a marvelous feat.

Finally, certain most obstinate diseases, such for example as tumors and cancer, are thought by some authorities on the subjects to be of the nature of embryonic or indefinitely growing tissues. These diseases finally cause their hosts to succumb. If now we have or know of chemical substances which may induce an embryo to develop at a rapid or at a slow rate, just as some salts may cause a muscle to contract fast or slow, then why may not something be found which will regulate or control the malignant growths, and perchance destroy them? These are some of the answers to our practical query, and let us hope that this now new science, the experimental study of development, which we have seen do so many remarkable things, will add many more.

COMPARISON OF A STEAM-DRIVEN AND A GAS-DRIVEN BATTLESHIP OF THE SAME SIZE AND SPEED.

The widely-circulated statement that the British government was contemplating the construction of a large battleship driven by producer-gas engines, which in spite of its lack of authenticity has obtained considerable credence, lends particular interest at this time to a paper which was read last year before the Institution of Naval Architects by James McKechnie, chief engineer of Vickers, Sons & Maxim. In this paper, which dealt with the influence of machinery on the gun power of the modern warship, the author took up the question of the economy in weights which would be realized by the substitution of gas engines for steam engines, and shows that in a ship of given displacement and speed the substitution of gas engines would render it possible not only to greatly increase the gun power, but also to improve the efficiency of these guns by enlarging their arc of fire, the latter result being due to the complete abolition of smokestacks. The author of the paper considers that, in warship design, the introduction of an exclusive armament of big guns has brought us to a stage in design where great changes are suggested, if, indeed, they are not imminent. The introduction of the all-big-gun armament complicates the question of placing the guns so that they will not interfere with the machinery spaces. At the same time, to obtain maximum efficiency every gun should be so placed as to enable it to fire from either broadside, and also to secure for the whole armament a maximum of bow and stern fire. In a ship propelled by steam machinery, the position of the boilers and of the engines can be modified only to a very limited extent, and the presence of uptakes and funnels interferes with the placing of the guns. This objection was not serious so long as the armament included large guns at the bow and stern only, with secondary pieces mounted along each side; but since all the guns of large caliber involve heavy training and elevating machinery, as well as ammunition hoists requiring large area of considerable depth, the limitations on the effective placing of the guns have been intensified. The adoption of internal-combustion engines would at once remove these difficulties, and would enable a larger number of heavy guns to be carried.

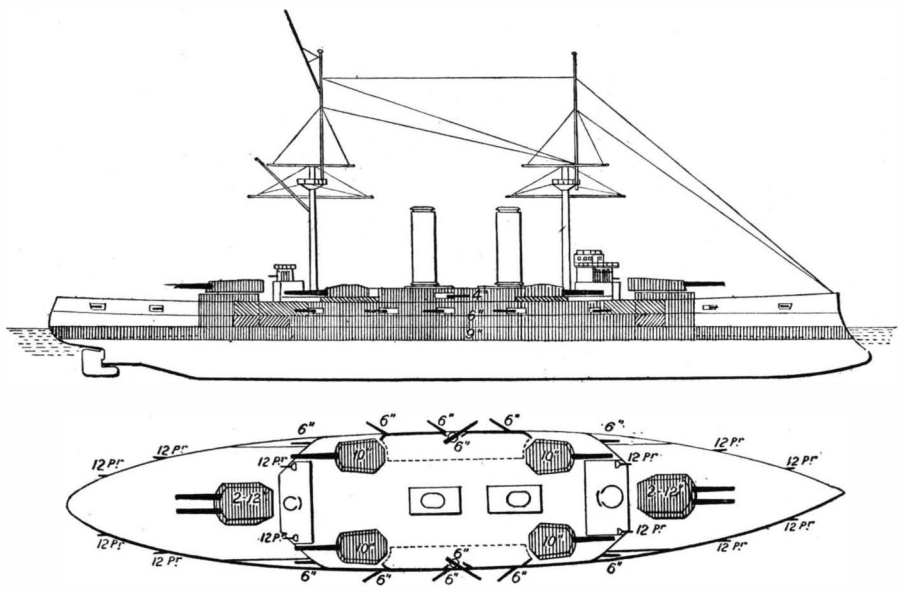
After several years' experimental work, the Vickers Company have adopted a two-stroke cycle gas engine, which may be worked either by producer gas, heavy oil, or compressed air. It may be made reversible as easily as the steam or compressed-air engine. It is possible to use in conjunction with it pressure-gas generators, which deliver their gas direct to the engine without the necessity of passing it through a scrubber or any other cleansing apparatus. The cycle upon which the engine works renders it possible also to recover the heat of the exhaust gas, and to utilize it in the engine. The compressed-air plant may be located in any part of the ship, and from this plant one main leads direct to the propelling engines, and another to the pressure-gas producers. The engine may be worked either by gas or heavy oil, so that coal may be stored in the bunkers and oil in the double bottom.

The drawings in Fig. 1 illustrate a battleship constructed at the Vickers works at Barrow-in-Furness, and the illustrations in Fig. 2 show a design of a corresponding vessel fitted with the producer-gas engines already described. The advantages alike in weight, space, and arrangement, resulting from the use of the gas machinery, have been utilized to improve the gun power.

The gas machinery is divided into three groups accommodated in six compartments. The ship has four propeller shafts, each driven by a 10-cylinder vertical gas engine. Two of the sets of engines are placed, each in the fore-and-aft line, in each of the after compartments. The engines are purely for propelling the ship. The gas producers, of the pressure type, occupy the two center compartments. In the forward compartments there are four sets of air compressors driven by gas engines.

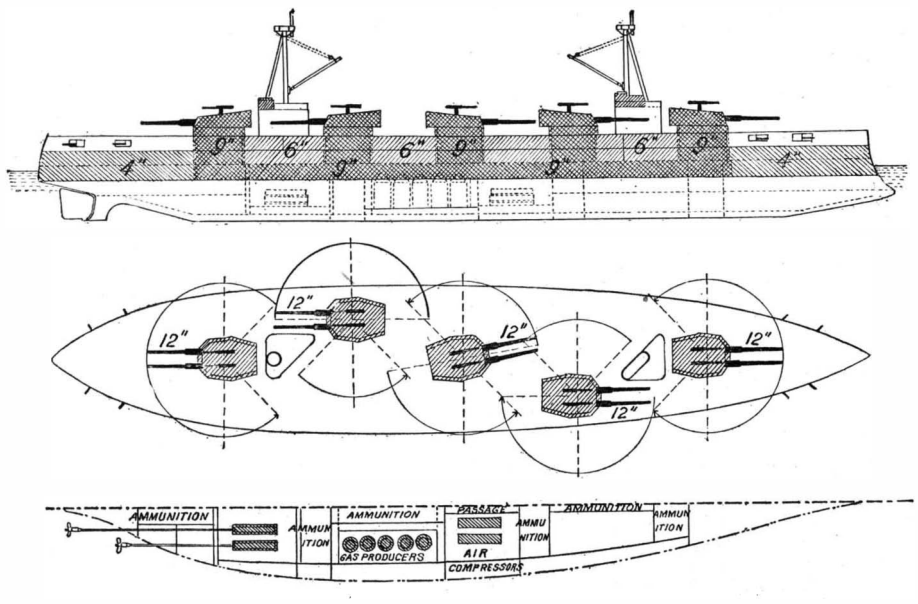
Heavy-oil engines would be used for driving the electric generators for lighting the ship and for supplying current to motors for working the steering and anchor gear, the ship's pumping machinery, etc. But this electric generating plant could be fitted in any position in the ship found most convenient.

As of some interest, although not vital to the consideration of the influence of this machinery on the gun power of warships, the approximate weights of steam, gas, and oil machinery of a 16,000 horse-power battleship are given in the accompanying table. These figures would, of course, be subject to alteration when the details of design are made to meet specified conditions.



Armament: Four 12-inch; four 10-inch; twelve 6-inch guns.

Fig. 1.—Outboard Profile and Deck Plan of 16,350-Ton Steam-Driven Battleship "Dominion."



Armament: Ten 12-inch: eighteen 4-inch guns

Fig. 2.—Outboard Profile, Deck Plan, and Hold of 16,350-Ton Gas-Driven Battleship.

COMPARISON OF WEIGHTS, ETC., OF STEAM, GAS, AND OIL MACHINERY FOR 16,000-HORSE-POWER BATTLESHIP.

	Steam Engine	Gas Engine	Oil Engine
I.H.P. available for propelling the ship	16,000	16,000	16,000
Weight of machinery including usual auxiliaries, but not deck machinery	1,585 tons*	1,105 tons †	750 tons ‡
I.H.P. per ton of machinery.	10.1	14.48	21.33
Area occupied by machinery, engines and boilers or producers.	7,250 sq. ft.	5,850 sq. ft.	4,110 sq. ft.
Area per I.H.P.	453 sq. ft.	366 sq. ft.	257 sq. ft.
Fuel consumption in pounds per I.H.P. per hour:			
At full power	1.6 lbs.	1.10 lbs.	0.6 lb.
At about ¼ full power	1.66 lbs.	1.15 lbs.	0.75 lb.

* Includes water in boilers.
† Includes water in jackets and piping, but not coal in producers.
‡ Includes water in jackets and piping.

A reference to the steam-driven battleship in Fig. 1 will show that this vessel was fitted with four 12-inch, four 10-inch, and twelve 6-inch guns—the most effective combination of ordnance in any warship up to 1905. In the new ship (Fig. 2) it has been found possible, without increasing the length or displacement, to introduce five pairs of 12-inch guns, and to carry eighteen quick-firing guns of 4-inch caliber for repelling torpedo attack.

Reference to the plan of the machinery and magazine arrangements in Fig. 2 will establish the advantage of the gas system. Here we have each of the main magazines located immediately under the pair of guns which it is intended to serve. Moreover, there is communication between the various ammunition and shell rooms. This has the important advantage of enabling ammunition to be distributed throughout the ship with the greatest facility all on one level. In the event of any turret being put out of action, the ammunition reserved for the guns in it could be used for other

weapons, all being transported below the armored deck.

The benefit derived from the abolition of boiler uptakes and funnels is still more marked. It enables the turrets to be so disposed, without increasing the length of the ship, as to admit of all the ten guns being fired on either broadside. This more fully realizes the demand for "all-round fire" for all guns than is the case in any existing ship. It will thus be seen that the internal-combustion engine installation allows a much greater range in the gun distribution, and is more adaptable to a reasonable arrangement of magazines, than is the case with steam machinery. Moreover, the temperature in the machinery room is lower, and fewer difficulties are involved in the satisfactory heat isolation and ventilation of the adjacent magazines.

In comparing the designs, it should be kept in mind that the object is to eliminate any other variant than machinery and gun power, although the actual weight of protective material has been increased. The second design (Fig. 2) is not put forward as representing an ideal battleship. In producing a design it is, of course, necessary to give attention to other considerations than that of gun power. Thus, part of the saving of weight and of space could be utilized for decreasing the size of the ship, while maintaining the same armament and protection as in the steam-driven battleship. Or the weight saved might be used for increasing speed by fitting more powerful machinery, although in this particular case an increased speed would be more economically realized in association with increased length of hull.

The design, however, clearly shows that greater gun power, and a fuller utilization of such offensive power, is possible with the internal combustion engine. The machinery is at a lower level in the ship, and is, consequently, better protected. As the power per unit of weight of fuel consumed is greater, the radius of action for the same allowance in displacement would be greater. Although the various points in favor of gas engines as a driver for warships, as given in the above digest, are well made, it must be borne in mind that the largest marine gas engines as yet installed are of insufficient size and much experimental work must be done before any application to a costly battleship will be warranted.

LIMIT OF HEIGHT FOR TALL BUILDINGS.

The height of the loftiest buildings successively erected in New York city is increasing by leaps and bounds. The topmost point of the Singer Building, recently opened, is 612 feet above the sidewalk; the finial of the lantern that crowns the Metropolitan Life tower is 700 feet above the same level; and recently plans were filed with the Building Department for a tower building to be erected by the Equitable Life Company, at Pine Street and Broadway, from whose summit, 909 feet above street level, it will be necessary to look down some 300 feet to find the top of the Singer Building, the next highest structure in the down-town district. The question not unfrequently asked by the work-a-day citizen, as he watches this modern attempt to pile Pelion on Ossa, is: "Where is this sort of thing going to stop? Are there no limiting conditions which will prohibit the extension of these steel-and-masonry wonders into the heavens?" The popular impression is that a building much higher than the Singer tower must necessarily crumble under its own accumulated weight, or be blown down by the gales of the winter or the fierce, if briefer, tornadoes which hurl themselves at Manhattan Island, in the shape of summer thunderstorms from New Jersey.

Now, as a matter of fact, the limit upon height comes neither from the inherent weakness of the building, nor from the overturning or racking effects of the wind. Under existing conditions, the ultimate limit of height is determined by a certain clause in the present Building Code of the city of New York, which says that the maximum pressure under the footings on a rock bottom, if caisson foundations are used, is not to exceed 15 tons per square foot. That is to say, if the architect and builder and the owner see fit to do so, they may keep piling story upon story, until the pressure upon the rock underlying the foundations has reached a maximum of 15 tons to the square foot. When that point has been reached, and not until then, the Building Department steps in and cries "Enough"; but it has nothing to say regarding the height to which the building may have been carried. This may be anything which the whim or purse of the owner and the skill of the engineer-architect may choose to make it.

There are other limitations in the Building Code, it is true, which affect the height indirectly by adding to the weight. Thus, the Building Code states that the walls of the steel-skeleton type of building are to be 12 inches thick for the uppermost 75 feet of their height, and increased 4 inches in thickness for every 60 feet below that; that the building must be capable of withstanding a wind pressure of 30 pounds per square foot from bottom to top; and that the overturning moment due to wind must not exceed 75 per cent of the stability moment of the structure.

What then is the maximum height to which a building can be carried subject to the above conditions? By the courtesy of Mr. O. F. Semsch, chief engineer for Mr. Ernest Flagg, the architect of the Singer Building, we are enabled to answer this question, and present an illustration showing the mammoth structure 2,000 feet high which it would be possible to erect upon an area 200 feet square without exceeding the Building Code limit of 15 tons to the square foot foundation pressure. Mr. Semsch was responsible for the design of the steel work of the Singer Tower, and the weights and other calculations of this 2,000-foot suppositional tower were worked out upon the same general principles as were used in designing the steel work of the towering structure at Liberty Street and Broadway.

The customary story height for office buildings is 13 feet 4 inches from floor to floor. After various trials Mr. Semsch found that a building of 150 stories, 2,000 feet in height, would practically be the limit under the above restrictions of the Building Code. He assumed this structure on a lot 200 feet square, and made approximate calculations. The walls of the building would be 12 inches thick at the top, and 140 inches, or almost 12 feet thick, at the bottom. Assuming two-thirds of the wall surface for windows, these walls would weigh, if built of brick, 203,000 tons; and assuming the dead weight of the floors and other interior construction at 80 pounds per square foot of floor area, the weight of that part of the building would be about 213,500 tons. The "live" floor load to be transmitted to the foundations, according to the requirements of the Building Code, would be 100,000 tons. Adding these items, we get a total weight of 516,500 tons. This, distributed over the entire area of 40,000 square feet available for footings, would result in a pressure of 13 tons per square foot.

The allowance for increase of pressure due to wind, and the weight of the footings themselves, would easily bring this figure up to the limit of 15 tons per square foot. This would mean that there would have to be one solid block of concrete covering the entire area of the lot.

The total wind-load on one side of this building, when exposed to a heavy gale of wind, would be 6,000 tons; and as the center of pressure would be 1,000 feet above the street level, the overturning moment due to this pressure would be 6,000,000 foot-tons.

Now, at first thought, the layman might be well excused for believing that a pressure of 6,000 tons applied to this building at a height of 1,000 feet above its base must surely turn it over; but the dead weight of the huge mass is so great that it would require, as a matter of fact, over eight times as much pressure upon the side of the building before overturning moment commenced. For, opposed to the overturning moment of 6,000,000 foot-tons, there would be a moment of stability of 51,650,000 foot-tons; that is to say, the wind moment would equal not quite 12 per cent of the moment of stability. Since the Building Code, as noted above, permits the wind moment to come within 75 per cent of the stability moment, it is evident that this structure for all its 2,000 feet of height would be perfectly secure against being blown down.

Mr. Semsch states that if a good rock bottom were so near the surface of the ground that it would be unnecessary to sink a caisson, a steel grillage or other form of spread foundation could be used, in which case the Building Bureau would probably allow of a somewhat greater load per square foot than 15 tons—although that is not specifically set forth in the Code. If this were allowed, it would be possible to go still higher than two thousand feet; but it is evident that the thickness of walls in the lower stories and the size of the columns would soon become prohibitive.

The experience gained in connection with the designing of the Singer Building, leads to the belief that a building of this height would require a mezzanine story in every fifteen stories for the placing of tanks, distribution of pipes, and service rooms. Looked at from this point of view, the building would really be equivalent to ten fifteen-story buildings placed on the top of each other.

In working out a design for the architectural features of this tower, as shown on our front-page engraving, Mr. Semsch made the general outline conform to that of an obelisk, divided into four 30-story and two 15-story sections, with belt courses formed by projecting stories. Such a tower, if constructed and equipped like the Singer Building, would cost approximately $60,000,000.

To Silver Horn.—The horn perfectly freed from oil is painted with a saturated solution of gallic acid and then with a solution of 20 parts of nitrate of silver in 100 parts of water. Repeat the coatings alternately until the black color is replaced by a slight silver tint, then paint once more with the silver solution. Rubbing down with cream of tartar solution completes the silvering.

Correspondence.

The Fastest Warship.

To the Editor of the SCIENTIFIC AMERICAN:

I notice in your last issue an article headed something like this: "The Fastest Warship Afloat." Then the article goes on to describe the latest American scout "Salem," stating that she steamed 26.88 maximum with an average of something over 25 knots. Then the statement is made that she is the fastest warship and the "Chester" the next fastest warship afloat, barring torpedo-boat destroyers.

With all due respect, I beg leave to contradict the above statement. You say that report has it that the cruiser battleship "Indomitable" made a greater speed, but it is not confirmed. This may arise from the fact that there is a good deal of secrecy concerning the movements, etc., of this class of ship. They have undergone, as you probably know, one series of both gunnery and speed trials, and it is understood they are to undergo future trials. Now the "Indomitable" made the following results: On her two-fifths power trial from the Clyde to Portsmouth she steamed 16.1 knots all the way; on full power trials she steamed for one hour 28.7 knots, or nearly 2 knots faster than the "Salem," and exceeded 28 knots for nearly six hours, or about 3 knots faster than the average of the "Salem," and she is credited with a burst of speed at 29.2 knots. For over 24 hours she maintained a mean speed of 26.2 without any undue forcing, which would be about one-quarter knot faster than the maximum average of the "Salem." My information comes through the British Navy League offices, 13 Victoria Street, Westminster, S. W., London, and is authentic.

W. R. SHUTE.

Dartmouth, Nova Scotia, July 7, 1908.

[In publishing the above letter, we draw attention to the fact that the speeds given are not official. The "Salem" holds the fastest official speed record.—ED.]

Dr. Wiley to Test Infant, Poultry, and Cattle Food.

Dr. H. W. Wiley, the head of the Bureau of Food and Drug Inspection of the Department of Agriculture, will undertake a comprehensive investigation of baby foods.

The basis for the baby food campaign is understood to lie in the fact that many mothers have written to the Bureau of Food and Drug Inspection that their children have failed to thrive on the preparations and in some instances have died after a diet of some much-advertised concoction.

There are also plans for cattle and poultry food campaigns. The Bureau in a recent circular has declared:

It has recently come to the attention of the department that a number of cattle and poultry foods sold on the American market contain enough poisonous weeds, such as corn cockle and jimson weed, to have a more or less toxic effect upon poultry and cattle. Poultry and cattle foods which contain poisonous weed seeds in appreciable quantities will be considered as adulterated in accordance with the provisions of the Food and Drug act of June 30, 1906.

The words "cattle food" or "poultry food" should apply to cattle or poultry foods which are not mixed with any condimental substance or substances; mixtures of cattle or poultry materials with small quantities of condiments such as anise seed, ginger, or capsicum should be labeled as "condimental cattle food" or "condimental poultry food."

The Current Supplement.

A comprehensive and extensive scheme for the supply of electricity both for power and lighting from peat gas is being projected in Ireland. The scheme is described and illustrated in the opening article of the current SUPPLEMENT, No. 1699. Prof. Silvanus P. Thompson, the well-known English physicist, contributes a history of the development of electric motive power. In the twenty-second installment of his "Elements of Electrical Engineering," Prof. Watson discusses the theory and construction of storage batteries. At the present time much interest is being aroused in Great Britain by a new fusion process for manufacturing salt. The process is described fully. Dr. H. S. Hele-Shaw and Douglas Mackenzie write on the problem of road construction. Sir James Dewar's recent lecture at the Royal Institution on "The Nadir of Temperature and Allied Problems" is digested. Naval Constructor Robinson's excellent paper on an "Experimental Model Basin" is concluded.

Helium Really Liquefied.

It is announced from The Hague that Prof. Ohnes, of the University of Leyden, who retracted lately his provisional statement that he had succeeded in liquefying helium, has now absolutely succeeded. He obtained on July 10 fifty cubic centimeters of liquid helium, which remained in that state for fifty minutes. The boiling point of the liquid was 268 deg. C. below zero, equivalent to about 450 deg. below zero F. More details will be looked for with interest.

THE WIDENING OF THE SUEZ CANAL.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

Owing to the steady increase of the dimensions and displacement of steamships plying between Europe and the East *via* the Suez Canal, the task of maintaining an adequate passage through the canal is one of great magnitude and difficulty. Operations have to be carried on incessantly in order to accommodate the waterway to the increasing size of the vessels that avail themselves of this route. When opened in 1869 the canal was from 150 to 300 feet wide at the water level by 72 feet wide at the bottom and 26 feet deep. In a short time these dimensions were found to be totally insufficient, and at last the question of enlarging the canal throughout its entire length of 100 miles became urgent. The problem was investigated, and a comprehensive scheme drawn up by the Suez Canal Company for enlarging the canal to double its original size; the work to be carried out in sections, and upon such a basis that the service of the waterway would not be interfered with. An appropriation of $5,000,000 was made for this purpose in 1901. This scheme has been pushed forward during the past three or four years with great activity, and it is anticipated will be completed within the next four or five years.

Up to December 31, 1906, the total cost of construction had amounted to $122,496,840, while the revenue has steadily increased from $6,234,938 in 1876 to $22,397,824 in 1906, the net dividend in that period having risen from $5.21 to $28.20 per share. During 1906, 3,975 vessels passed through the canal, representing an aggregate tonnage of 13,445,504 tons. While this shows a decrease of 141 vessels as compared with the previous year, the tonnage increase is 311,399 tons.

Owing to the waterway passing through the Arabian desert, the greatest danger confronting the authorities is the silting up of the canal by sand, the movements of which are tremendous. A comprehensive idea of the work entailed in this direction alone may be gathered from the following figures, which represent the amount of material excavated from the canal itself during the past three years:

1904	1,353,497 cubic yards.
1905	1,760,864 cubic yards.
1906	1,918,595 cubic yards.

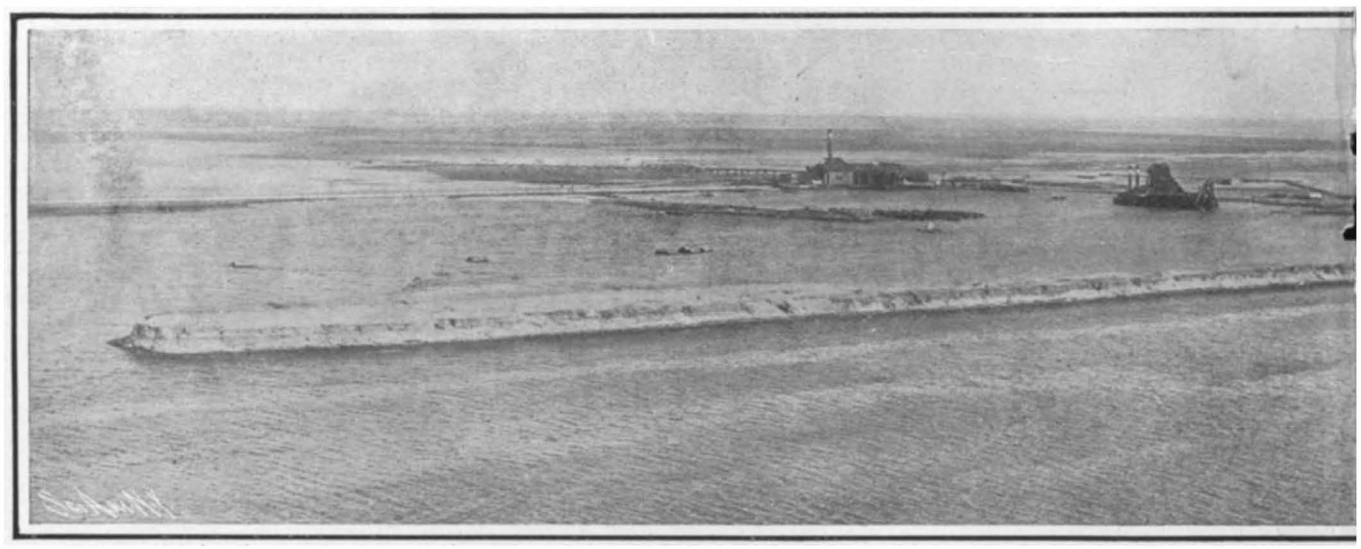
In addition to this, the extent of the dredging necessary at Port Said aggregated during the same period 1,933,348, 1,842,772 and 1,464,935 cubic yards respectively.

In 1904 a minimum depth of 28 feet was maintained for the whole distance between Suez and Port Said, sufficient to admit vessels having a maximum draft of 26 feet. In this same year twelve new gares or crossings, where vessels proceeding in opposite directions are able to pass one another, were completed, while plans were prepared for the construction of twenty-one similar gares, each 2,460 feet in length, near the various lakes. Arrangements were also completed for deepening the canal to 34½ feet, a task which will be accomplished within the next five years.

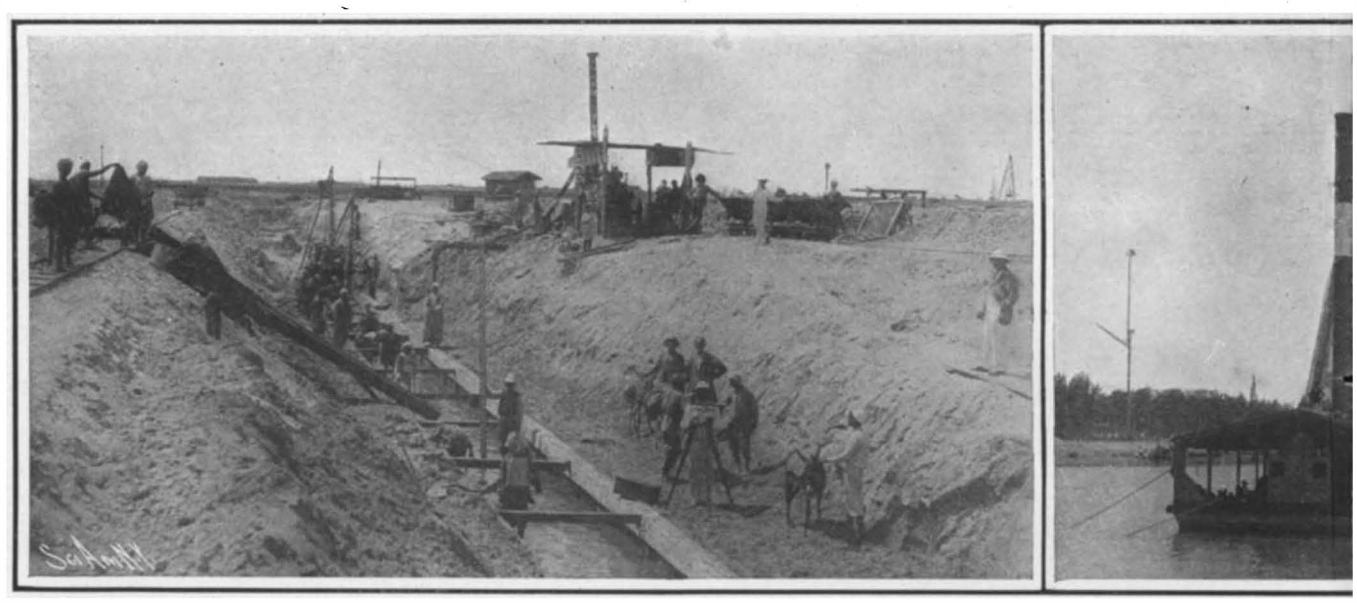
In order to enable this work to be carried out with all expedition, the authorities acquired an extensive dredging and excavating plant, including a powerful bucket dredger with attendant lighter and five carrying barges of 520 cubic yards capacity, together with two water-tank lighters, one 60-ton floating shear-legs, and a 12-ton floating crane. For the convenience of vessels, a 3,000-ton floating dock was obtained for use at Port Said, thereby obviating the necessity of any ships, more particularly the dredging appliances of the company, proceeding to Suez for drydocking.

The actual amount of excavation carried out in 1904, when the canal was widened by 50 feet to insure a maximum width at the bottom of 147 feet, aggregated 1,689,275 cubic yards of earthwork and 1,863,646 cubic yards of dredging. The ballast above the water level is removed by manual labor, terraces being cut into the banks, along which temporary railroad tracks are laid. From the water level to the prescribed depth dredgers of various types are employed, some cutting their way into the bank and dumping the excavated material by means of overhead transporters upon the bank, and others discharging it into lighters. The ballast for the major part consists of sand, the rock encountered being approximately four per cent of the total amount. In the dredging of the navigable channel itself the type of dredger with floating conduit is most favored, the excavated material being discharged through the pipe, usually where the bank is somewhat low-lying, thereby building up an artificial embankment, which is subsequently planted with suitable vegetation.

One of the greatest menaces against which the authorities have to contend is the stranding and foundering of vessels, whereby the passage through the canal is blocked. In 1905 such accidents averaged 1.7 per cent of vessels passing through, whereas in 1885 the average was 4.3 per cent. This improvement is attributable directly to the widening of the waterway, together with the improved facilities now in vogue for enabling vessels to proceed. In 1905, however, the resources of the authorities were severely taxed by the

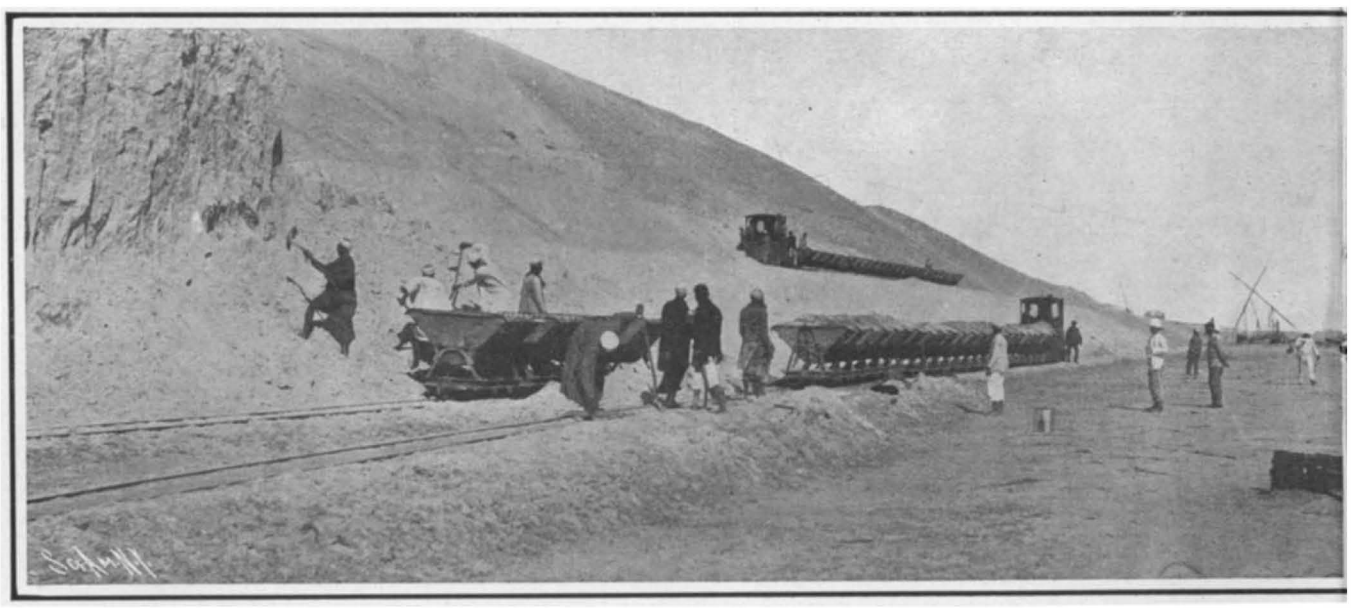


The Entrance to the Canal at Port Said; on the Left Are the Con

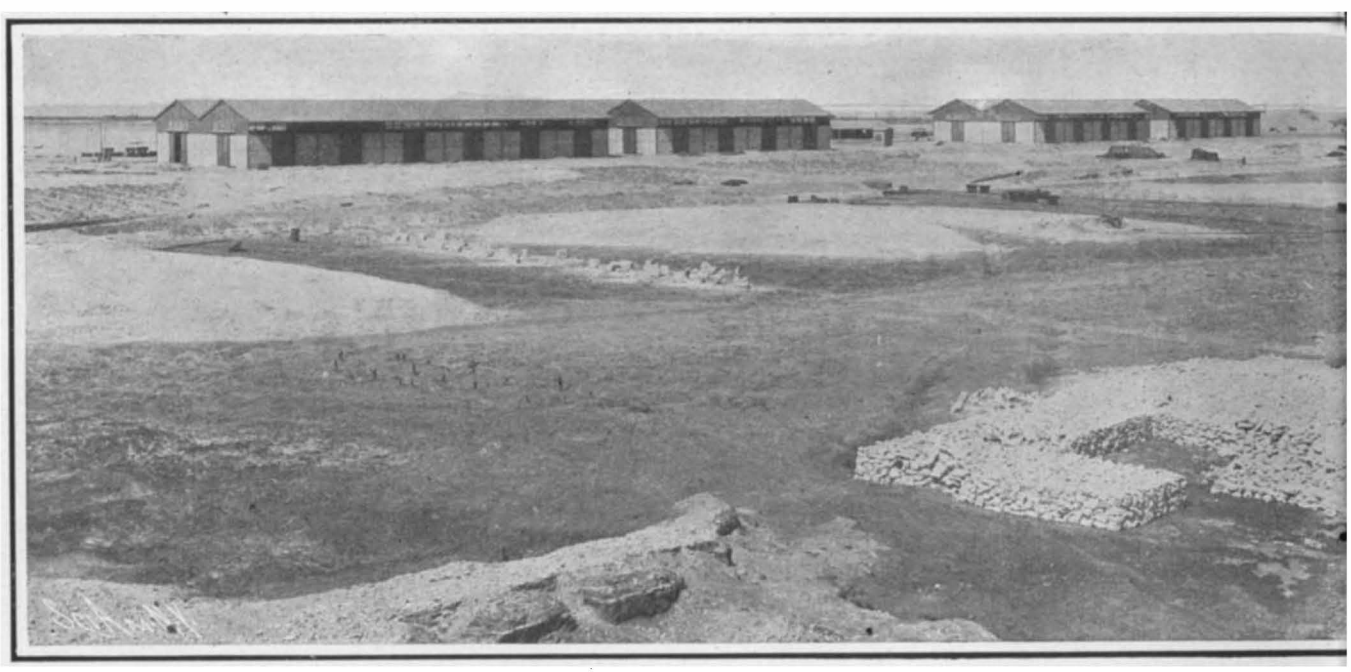


Excavating for the New Docks at Port Said.

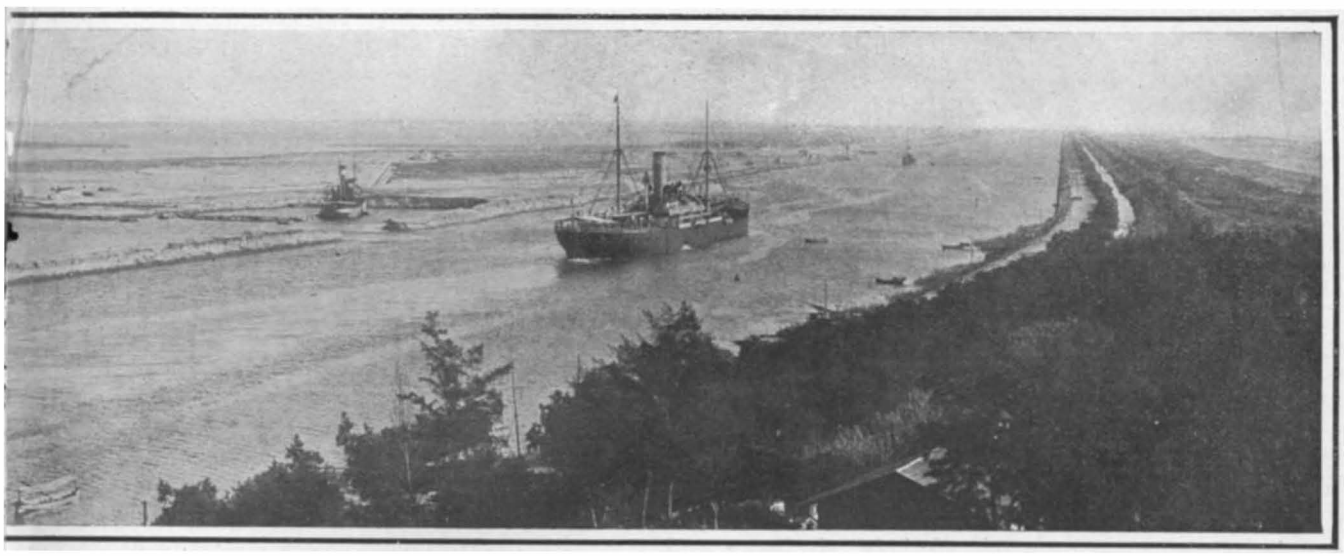
A Pontoon Rock



Above the Water Level the Earth is Carried Away in Cars on Temporary Railroads.

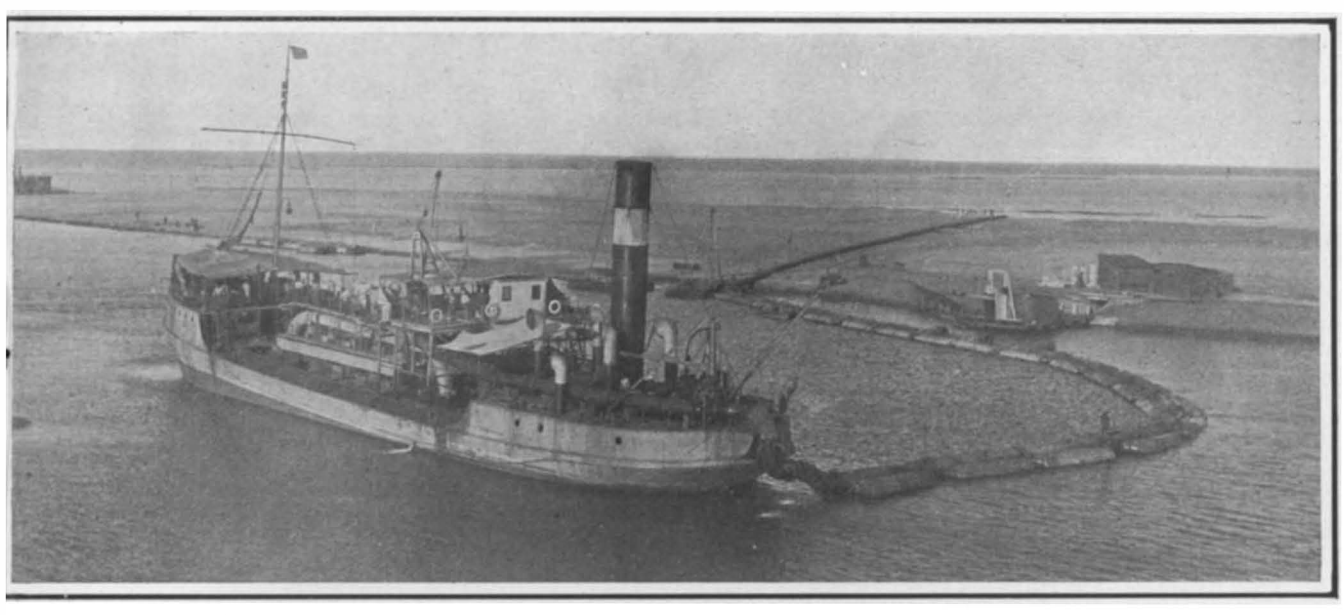


This View Gives a Good Idea of the Flat Land—Sand Deserts and Shallow Lakes—Through Which



struction Works for New Basins for Colliers and Petroleum Boats

eaker at Work. Manual Labor and Primitive Transportation Are Largely Used in the Work.



Below the Water Level the Dredger Works and Often Uses the Material for Raising Low-lying Banks.

the Canal Passes. It Shows the Works for a New Quay in Course of Construction at Cherif Basin.

THE SUEZ CANAL.

foundering of the "Chatham" by collision with another vessel. The ship sank in the center of the channel, tying up all navigation for several days. Within a period of four days the authorities had to handle no less than 109 vessels which had been delayed, 53 passing from the north, and 56 from the south, directly the channel was reopened, and this was successfully accomplished without the slightest hitch. The wreck itself was removed by being blown up, and the debris salvaged.

The work of widening the bottom of the Suez section of the canal by 50 feet was maintained during 1905, involving the removal of 1,570,476 cubic yards of earthwork and 914,316 cubic yards of dredging. In addition to increasing the width of the canal, the various curves are being rectified and eased.

During 1906 the extent of dredging aggregated 3,255,271 cubic yards, of which total 1,339,071 cubic yards were excavated by the Suez Canal Company, and 1,916,200 cubic yards by private enterprise. The extent of earthwork excavated amounted to 1,829,564 cubic yards.

From January 1, 1908, the maximum draft permissible for vessels passing through the canal will be increased to 28 feet, as the task of carrying the depth of water to 34½ feet throughout the entire length of the waterway will then be completed. In order to maintain this depth, the authorities have ordered a third dredger of the Lobnitz type, capable of dredging to 36 feet, and which will be one of the most powerful machines of this description in the world.

The new works comprise among other developments the construction of a new dock to the west of the railroad station at Port Said. The object of this is to encourage the building of warehouses, so that vessels may berth beside the piers, thus obviating the necessity of discharging into lighters and barges as at present. Should this first dock prove successful, a second and third will be laid out upon similar lines, and to which access will be possible from a navigable channel communicating with the canal proper. The opening of the Egyptian government railroad, by which Port Said is linked with Cairo, has resulted in a heavy traffic, vessels stopping at Port Said to unload their cargoes intended for Egypt. Consequently, on the African bank of the canal arrangements are to be provided for the unloading of colliers and other vessels and to assist in the erection of depots along the line of the railroad, the demand for which is at the moment very pressing.

The gare of Port Thewfik is to be deepened, and other improvements effected. To carry out this work will necessitate the excavation of about 4,810,000 cubic yards of earth and will occupy several years. In order to facilitate the enterprise, the Egyptian government will cede 358 acres of land at Port Said to the canal authorities for the construction of proposed docks.

At Port Said a number of basins and docks are in course of construction upon the Asian bank for colliers and oil boats. When these are completed, the space at present occupied by this class of traffic will be available for vessels carrying general merchandise destined for the interior of Egypt. The construction of new docks intended for general maritime traffic upon the Asian bank, together with the restoration of the eastern breakwater and its extension for 1,640 feet toward the northward, will be completed by 1912.

In connection with the general improvement scheme, a large tract of land has been reclaimed from Lake Menzaleh. A deep and wide channel has been dredged across the shallow waters of this lake, and a ferry service established by the Menzaleh Canal and navigation companies between Port Said and Matarieh, the eastern point of the fertile country of Mansourah. Ultimately this channel is to be connected to the main waterway by means of a lock; the present fresh-water canal extending alongside the main canal being siphoned under the channel.

Since 1896, $7,200,000 has been expended upon the widening and improvement of the canal. In that year the minimum superficies of the vertical profile was 504 square yards, while to-day it is more than 611 square yards, and with a depth from one sea to the other to admit vessels drawing 28 feet of water. More than twenty stations have been provided at various points between the termini, nearly all the curves have been eased and gares provided at intervals of about three miles. During the same period vast improvements have been effected concerning the welfare of the numerous employees engaged in the maintenance of this enterprise. The ravages of the mosquitoes and fever which formerly prevailed along the Isthmus have been subjugated. A modern sanitary system was evolved for Ismailia by the Egyptian government in co-operation with the company, the results of which have been completely successful. At this point a huge hospital has been erected, together with dispensaries, where the afflicted of the surrounding country receive free medical assistance and advice. A comprehensive idea of the natives' estimation of this interest in their well-being is afforded from the fact that the dispensaries of Ismailia and Port Thewfik have tended 120,000 cases and held over 500,000 consultations.

Coincident with the remarkable progress in the traf-

fic receipts and high dividends that prevail, the dues have been reduced. When first opened, the tariff for all laden vessels was $2 per ton; reduced to $1.90 in the eighties, and then further reduced to the existing levy of $1.50 per ton. The tariff for passenger vessels has always remained the same, however—$2 per ton. The reserve funds of the company to-day stand at $5,000,000; while a special fund, to which a certain sum is devoted every year for the acquisition of new machinery to maintain and improve the canal, is provided, which stands at $6,000,000.

PRESERVING GRAND OPERA RECORDS FOR FUTURE GENERATIONS.

A gift recently presented by an American to the French government has attracted widespread attention, as it demonstrates the unlimited uses to which that wonderful modern invention, the talking machine, may be put. Alfred Clarke, a New Yorker by birth, but a resident of Paris for a number of years, has had a vault constructed in the cellars of the Paris Opera House, in which have been placed hermetically-sealed leaden casks containing a number of records of the voices of present-day singers as well as some orchestral pieces. The idea is to preserve these records for posterity, so that a hundred years from now the mellow notes of Calve, Caruso, and Melba may be heard by people who were born many years after the death of these artists.

It is only comparatively recently that the talking machine has been so perfected that the reproduction of the human voice has become satisfactory and that these records could therefore take a place historically and scientifically interesting in the history of the world.

When Mr. Clarke first conceived his idea of thus perpetuating the voices of the great singers of to-day, he suggested his scheme to M. Charles Malherbes, the archivist of the Museum of the Paris Opera.

In presenting the subject, he asked M. Malherbes if he would not like to know exactly how Mozart executed one of his sonatas and how Molière recited his comedies. M. Malherbes naturally replied that such information would be interesting and valuable. Whereupon Mr. Clarke said that what our ancestors could not do for us, we could do for our descendants. He then unfolded his plan to preserve in the archives a collection of vocal and instrumental pieces which are now rendered at the Opera, so that musicians of the twenty-first century would know exactly at what tempo the conductor of the orchestra at this time rendered these compositions and how the singers interpreted their parts. M. Dujardin-Beaumetz, Under-Secretary of Beaux Arts in the French cabinet, gave M. Malherbes authority to proceed with the preparation of the records. Commenting on the ceremony of sealing the records in the vault of the Paris Opera House, the Paris Echo refers to it as a funeral for the burial of voices. In many ways this is a good description of what took place.

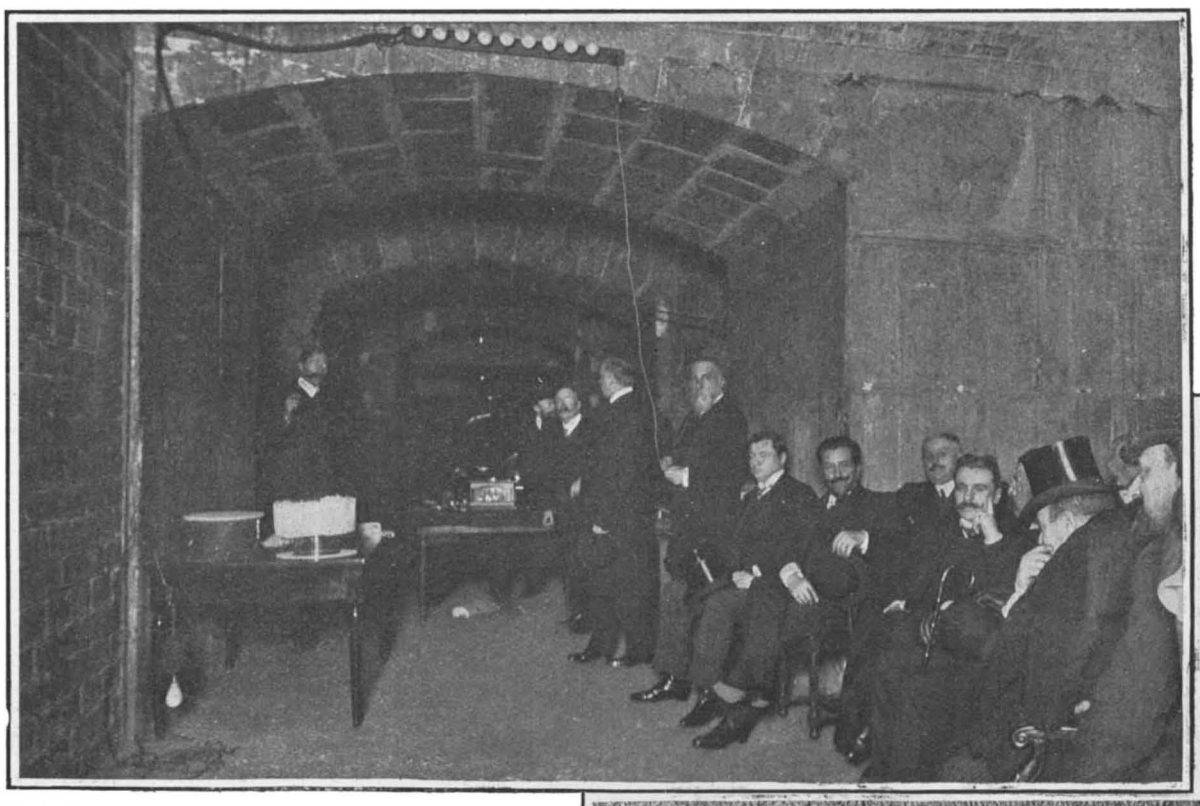
The records, especially prepared for the purpose, were made by Caruso, Scotti, Plançon, Tamagno, Melba, Patti, Schumann-Heink, Bonisegna, Calvé, Kubelik, Renaud, Pugno, and other virtuosi and artists.

These precious disks were placed in the vault before mentioned, the vault and its contents both being the gift of Mr. Clarke, and they were accepted on behalf of the French government by M. Dujardin-Beaumetz with appropriate ceremonies. The disks were made of a new preparation of hard rubber which is considered indestructible. Nevertheless every precaution to protect them from the ravages of time was taken. They were placed in hermetically-sealed receptacles and the door of the vault was closed and locked, the key being placed in the archives of the Opera. A tablet on the door states the name of the donor and the date.

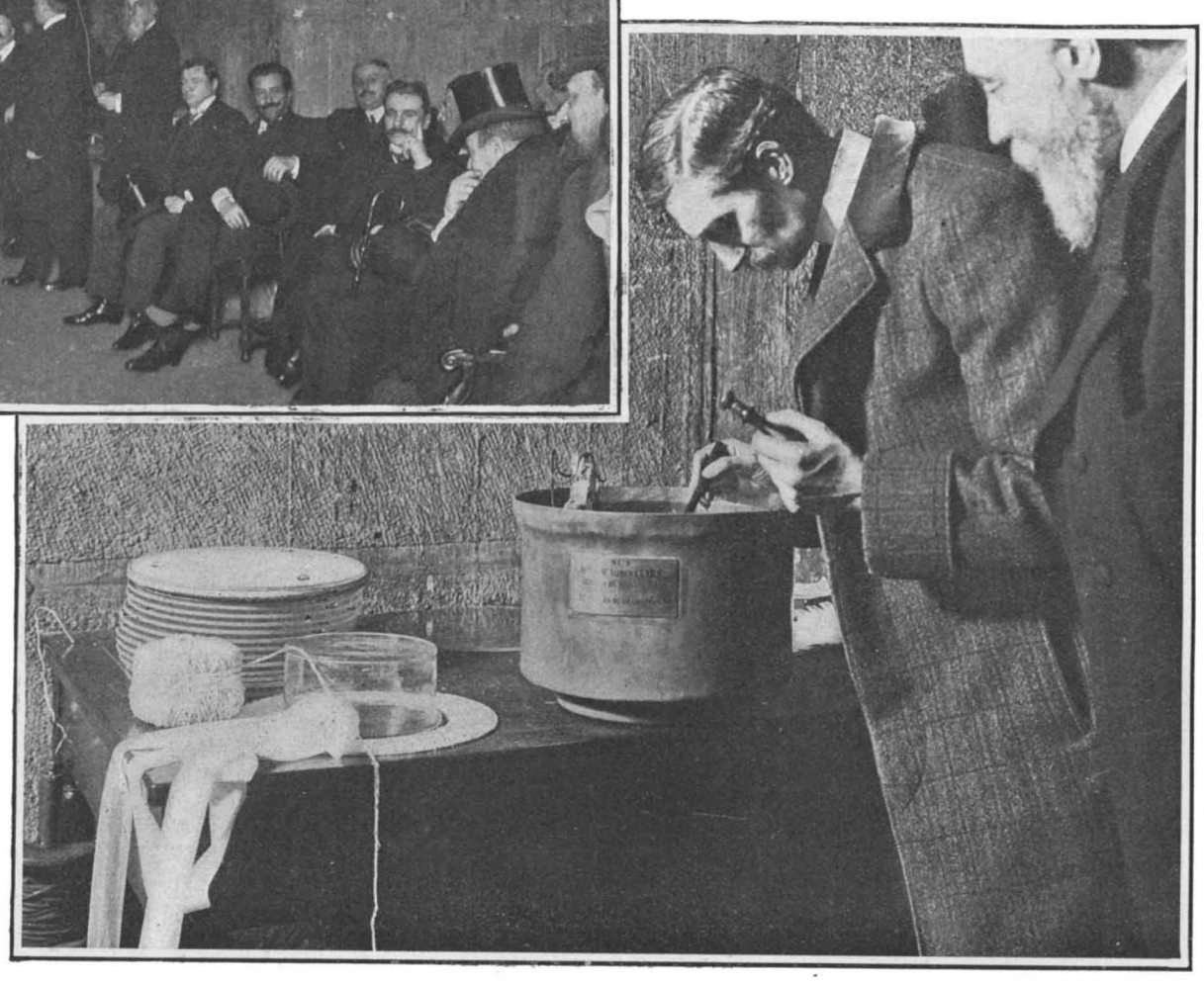
The impressiveness of the ceremonies, which were held in the dark cellars beneath the Opera and were attended by many distinguished men of letters, can well be imagined. The event was regarded as marking a new era in the arts.

The placing of the records in the library of the Opera was at first considered, but it was decided that there would be less danger of destruction by fire or earthquake if they were placed below ground.

A change from the original plan of closing the vault for one hundred years was also made, and it was agreed that it might be opened after fifty years with the permission of the Minister des Beaux Arts.



Passing on the Records Before Sealing.



Sealing the Records in the Vault.

PRESERVING GRAND OPERA RECORDS FOR FUTURE GENERATIONS.

All the essential parts of the machine for playing the records were also placed in the vault, so that if at the distant day when it is opened, the talking machine has been changed materially, these records may still be heard.

One of the most interesting circumstances in connection with the presentation was the speech made by M. Adrien Bernheim, one of the representatives of the government who was present, in which he quoted from something written by Theophile Gautier sixty years ago. Gautier said at that time: "Some day perhaps the critic, having become more enlightened, will have at his disposal means so that by stenographic notation he will be able to set down all the shades of meaning that an actor uses to portray the character. Then no longer shall we have to regret that all the genius dispensed at the theater is utterly lost for posterity. As now we have pictures perpetuated by the aid of light upon a sensitive plate, so we will attain the power in a manner more subtle still, to receive and hold the waves of sound, and to preserve thus the execution of an air by Mario, of a recitation by Mlle. Rachel, or a stanza by Frederic Lemaitre." That this prophecy, which was undoubtedly received with incredulity at the time it was uttered, should have been realized in so short a time is marvelous.

Mr. Clarke's idea has already been copied at the British Museum in London, practically the same records which were sealed up in Paris having been placed there. This is the inception of an entirely new field of usefulness for the talking machine, and its development along these lines will probably be unlimited. Mr. Clarke, who has been in this country for several weeks, has just returned to Paris.

More About the Radio-Activity of Sodium.

Some additional information is given by C. E. S. Phillips in Nature, regarding the alleged radio-active power of sodium. Mr. Phillips believes that the greater or less effect due to different portions of the same rod was caused merely by inequalities in the temperature of the sections examined. By lowering the temperature so as to reduce the oxidation of the surface, a more complete diselectrification was produced. This result seemed at first sight to point to a cause other than chemical action. A slight current of air and even a soap film were sufficient to stop the discharging effect, also supporting the view that an electrified gas was emanating from the metal. A bright surface of potassium gave no appreciable discharging effect when cooled with a mixture of ice and salt. In all cases the surfaces could be seen in the dark to be glowing strongly. Further experiment has shown that no active gas can be driven from sodium by heat, and that the true explanation of the action lies in the positive electrification of the air surrounding the freshly cut surface. With warm sodium it is seen that the gold-leaf falls rapidly for a very short distance, while after cooling the action is more prolonged. It is clear, therefore, that the action in the first case, although violent, is so transient, owing to the whole surface being rapidly oxidized, as to appear of small amount. A far larger discharging action was obtained with reduced oxidation because the effect is prolonged.

Remains of a Mammoth in California.

The remains of a prehistoric elephant of mammoth proportions were unearthed recently in the bed of a small creek in Puddingstone Canyon, half a mile north of San Dimas, by Prof. A. J. Cook, head of the department of biology of Pomona College, Cal., and Edward P. Terry, a student. The bone frame, which is in a fair state of preservation, measures 26 feet in length, and 16 feet in height, and what remains of each of the enormous tusks is 10 feet long. The parts of the huge skeleton that could be safely handled, were removed carefully to Claremont, and are to be placed in the museum of Pomona College. The discovery was accidental. The skeleton lay diagonally across the stream with only six inches of ground over it.

THE SOARING FLIGHT OF BIRDS ATTAINED MECHANICALLY.

BY JACQUES BOYER.

Prof. Marcel Deprez, of the Conservatoire des Arts et Métiers, the well-known pioneer in the electrical transmission of energy, has been conducting a series of experiments of great importance for the progress of aviation. He has succeeded with the aid of the simple apparatus illustrated in the accompanying photographs, in causing a body heavier than air to soar, without other motive power than that which is derived from the force of the wind.

The immobility of soaring birds is a phenomenon which has greatly puzzled mechanical engineers. The spectacle of an eagle with outstretched wings hovering motionless in the air is very impressive to a thinking observer, in whom it inspires vain speculations regarding the means by which the bird is thus enabled to remain suspended without muscular effort in a fluid 800 times less dense than itself.

Deprez has shown that this problem, which has formed the subject of many controversies, can be solved very easily by the fundamental laws of mechanics, and that the force of the wind is the only force required. This explanation involves no hypothesis whatever.

In the first place, the pressure exerted upon the surface of a solid by a gas, either at rest or in motion, is always normal to the surface. The whole effective force impressed upon the surface may also be regarded as normal, if the tangential friction between the solid and the gaseous molecules is neglected, but this tangential force may be taken into account without invalidating the conclusions which we shall presently reach. The ability of a bird to rise in the air and to travel against the wind without moving its wings is the result of a combination of forces and its only necessary requirement, as reason and experience agree in demonstrating, is the presence of a current of air directed slightly upward. The pressure of the wind on any element of the wing is normal to the plane of that element. If this pressure is resolved, in accordance with the principle of the parallelogram of forces, into a vertical and a horizontal component, it is evident that the vertical component is directed upward or in a direction opposed to that of gravity, and that the direction of the horizontal component is opposite to that of the wind. Hence the element of the wing which we are considering will be impelled against the wind. If the sum of these horizontal forces on all the elements of the wings is exactly equal to the sum of the opposing pressure of the wind on the body of the bird and the horizontal components of the frictional forces, the final resultant will be an upward force, and if this resultant is exactly equal to the weight the bird will rest motionless in the air, without flapping a wing. The attainment of these equalities between the vertical force and the weight and between the horizontal forces directed forward and backward is conditioned by the velocity, direction, and inclination of the wind, the form and position of the wings, and other circumstances which supply the numerical data of the problem. By applying this analysis to the action of the wind on curved surfaces Deprez has found that these are far superior to planes for the attainment of soaring flight.

These theoretical results have been confirmed by experiments made with the apparatus pictured in the accompanying photographs. The middle figure shows a curved vane of aluminium mounted on a little car which runs on rails slightly inclined to the horizontal. A current of air, having an inclination opposite to that of the rails, is blown obliquely against the under surface of the vane. When the vane and the air current are properly adjusted the car runs up the inclined track, against the air current and in defiance of gravitation. When the blower is stopped the car runs down the incline to its original position.

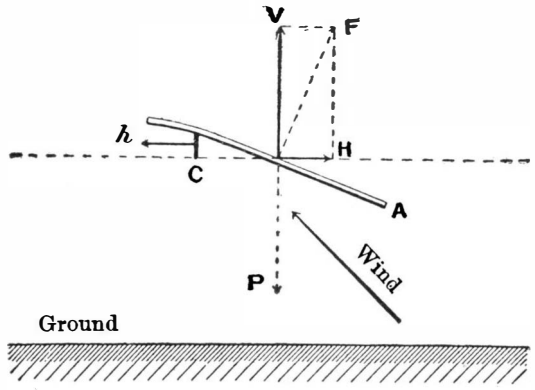
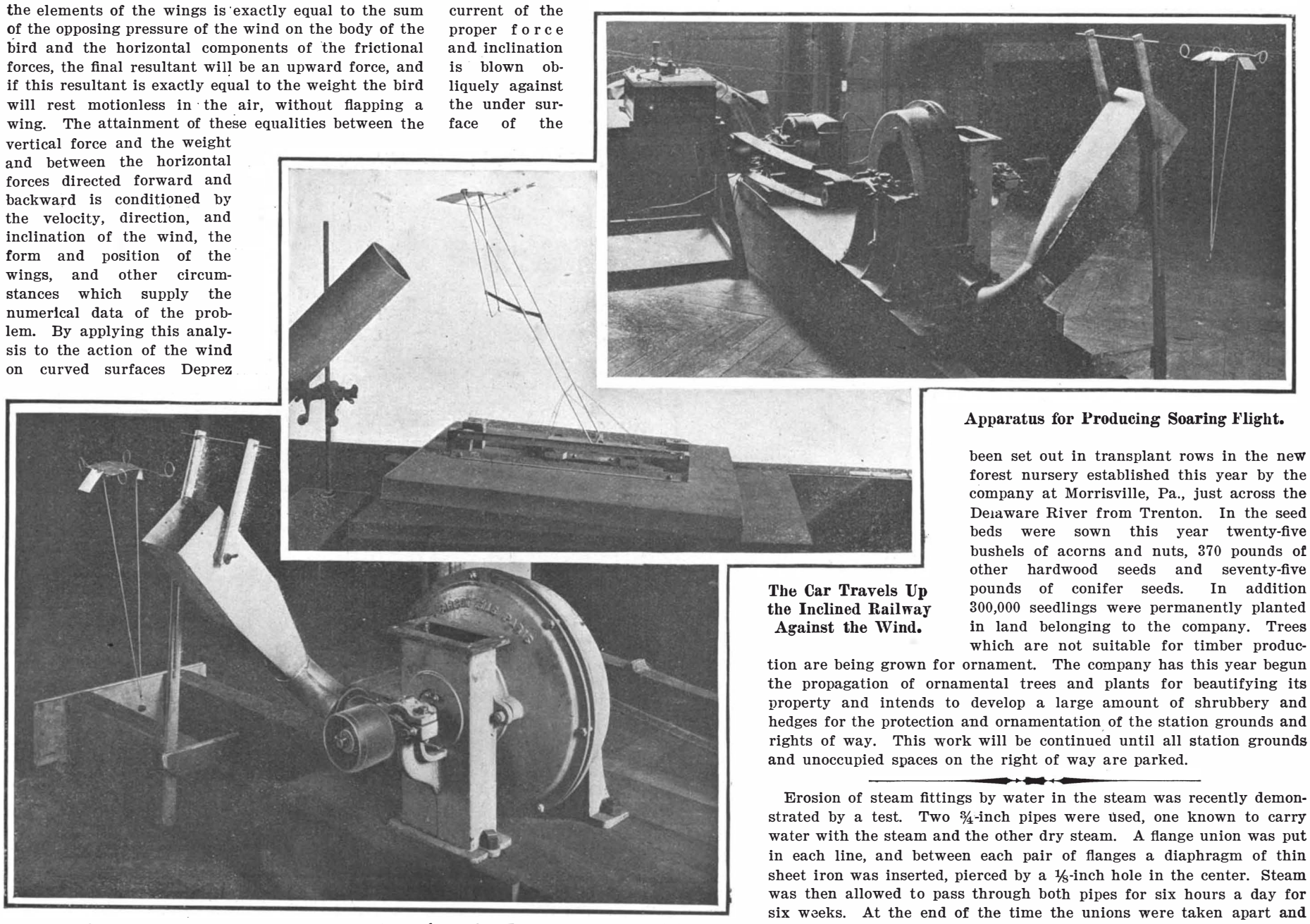


Diagram Illustrating the Mechanism of Soaring Flight.

Deprez produced motionless soaring, or hovering, by means of the apparatus shown in the other two photographs. This apparatus represents the geometrical scheme of a bird and consists essentially of a large and nearly horizontal plane surface, representing the extended wings, and a small vertical surface, representing the head and body. In the latest apparatus designed by Prof. Deprez and constructed by his assistant, M. Varney, the model of the bird is reduced to two plane sheets of aluminium. Wires, threaded through rings, support the imitation bird in the position of rest and limit its departures therefrom during the experiments. Stability is given by two long rods which support a weight hung at their joined lower ends. A blower and dynamo complete the apparatus.

When an air current of the proper force and inclination is blown obliquely against the under surface of the aeroplane, the latter ceases to rest upon the supporting wires and remains suspended freely in the air, like a hovering eagle or vulture, quivering in the unsteady current but neither rising nor falling, neither advancing nor retreating.

This result is explained by the diagram, in which *A* denotes the principal aeroplane and *C* the vertical plane, representing the body of the bird. Although the wind is only slightly inclined to the aeroplane the wind pressure is normal to the plane. *F* denotes this normal pressure, *V* and *H* its vertical and horizontal components, and *h* the normal pressure on the small plane. The force *h* always acts in the (horizontal) direction of the wind, but *H* acts in the opposite direction if the windward end of the aeroplane is lower than its leeward end, as in the diagram. In this case it is possible to adjust the inclination of the aeroplane and the inclination and force of the air current so that *H* is equal to *h* and *V* is equal to the weight of the apparatus, and thus to cause the latter to hover without motion. By modifying the conditions the aluminium bird can be caused to rise or fall and to move with or against the wind. Deprez has calculated that motion against the wind can occur only when the aeroplane is more nearly horizontal than the wind. The diagram explains, furthermore, why the ability to hover and to soar against the wind is confined to birds of relatively great wing area, for it is only in these that *H*, the horizontal component of the wind pressure on the wings, can equal or exceed *h*, the horizontal pressure on the body.



Under the Influence of the Current of Air Blown from the Fan the Little Aluminium "Bird" Soars in Space.

THE SOARING FLIGHT OF BIRDS ATTAINED MECHANICALLY.

Apparatus for Producing Soaring Flight.

The Car Travels Up the Inclined Railway Against the Wind.

Railroad Tree Planting.

In continuance of its plans to provide for some of its future requirements in timber and crossties the Pennsylvania Railroad forestry department has completed its spring forestry planting for this year. It set out 625,000 trees. These make up to the present time 2,425,000 trees which have been set out by the railroad since it undertook tree planting upon a comprehensive scale. Economically to prosecute tree planting operations on a large scale has necessitated the importation of much European plant material, which owing to the degree of perfection to which the European foresters have brought their work and the cheapness of labor can be purchased at a much lower price than in America. This year the Pennsylvania Railroad imported 209,000 seedlings, of which all not large enough to be planted in their permanent sites have been set out in transplant rows in the new forest nursery established this year by the company at Morrisville, Pa., just across the Delaware River from Trenton. In the seed beds were sown this year twenty-five bushels of acorns and nuts, 370 pounds of other hardwood seeds and seventy-five pounds of conifer seeds. In addition 300,000 seedlings were permanently planted in land belonging to the company. Trees which are not suitable for timber production are being grown for ornament. The company has this year begun the propagation of ornamental trees and plants for beautifying its property and intends to develop a large amount of shrubbery and hedges for the protection and ornamentation of the station grounds and rights of way. This work will be continued until all station grounds and unoccupied spaces on the right of way are parked.

Erosion of steam fittings by water in the steam was recently demonstrated by a test. Two ¾-inch pipes were used, one known to carry water with the steam and the other dry steam. A flange union was put in each line, and between each pair of flanges a diaphragm of thin sheet iron was inserted, pierced by a ⅛-inch hole in the center. Steam was then allowed to pass through both pipes for six hours a day for six weeks. At the end of the time the unions were taken apart and the diaphragms removed. The hole in the disk exposed to dry steam was unaltered, but that in the disk exposed to wet steam had been worn away so much that it resembled a keyhole.

RECENTLY PATENTED INVENTIONS.

Of Interest to Farmers.

CLEVIS.—R. H. SULLIVAN, Mount Vernon, Wash. The object in this case is to provide a construction which will facilitate the application of the draft in any desired manner. The device secures a greater scope of action at the side, bottom, or top, and the hitch may be adjusted to any extent desired without unhitching the team, and this adjustment can be easily accomplished in the field or elsewhere.

ATTACHMENT FOR CUTTER-BARS OF MOWERS AND HARVESTERS.—H. BEYREIS, Seneca, Kan. This simple improvement in the construction of clips overcomes several former difficulties and objections. It comprises a body portion, a lateral extension or toe for bearing upon a knife, the rear extension of the toe intervening and being separated from the end portions of the body, the whole being formed integral and of spring material.

Of General Interest.

FIRE-ESCAPE.—G. E. METTER, Seaside, Ore. One purpose of the inventor is to provide a fire escape that is a fixture upon a building, and which is in the nature of an endless conveyer extending from the cellar to the roof, which conveyer is so constructed as to provide foot-holds and hand-holds for the persons ascending and descending.

PROCESS FOR IMPROVING THE PHYSICAL PROPERTIES OF METALS AND THEIR ALLOYS.—D. LAMON, Deriver, Col. This process is for use in improving certain of the physical properties of the metals and their alloys without deteriorating any of the valuable properties which they may already possess. Any suitable form of furnace may be used providing for continuous or intermittent operation, but it is preferable that the source of heat be an impinging low-luminous flame.

CEMENT PAVING.—R. KIESERLING, Altona (Elbe), Germany. According to the present invention a layer of concrete or cement is employed, which may be upon a second such layer, gutters of U or V section; and these gutters are filled with some elastic substance, such as tar, mastic-cement, or the like. From the walls of the gutter project lugs, which are surrounded by the concrete, whereby the gutters are firmly held in place in the material. This application is a division of the one formerly filed and for which a patent was granted to Mr. Kieserling.

PROCESS FOR PURIFYING WATER AND SEWAGE.—A. E. WOOLF, New York, N. Y. The invention has reference to the purification of water and sewage, and more particularly to the disinfection of the liquid by means of an electrolyzed saline solution. A saline solution is preferably employed as a basis, but the inventor does not limit himself to this particular application.

METALLIC HEAD FOR VESSELS.—E. C. THORSCHMIDT, New York, N. Y. A purpose in this case is to provide a head particularly adapted for open wooden vessels, but which is equally applicable to metal vessels such as pails, tubs, barrels, and the like, which head is in two sections, namely a cover section and a clamping hoop therefor, the sections being primarily formed from a single piece of metal suitably struck up, and which is then cut and each section independently and individually finished.

Hardware.

LOCKING DEVICE FOR THE WELL-DOORS OF DUMB-WAITERS.—A. E. FISCHER, New York, N. Y. The device is capable of being manipulated on any floor of a building for locking the closed well-door of one floor while unlocking the same of another and vice versa, thus rendering it impossible for both doors to be open or partly open at the same time, thereby preventing draft in the well and consequently reducing the spread of flames by way of the waiter well in case of fire in the building in which the dumb waiter is located.

BIN.—W. C. HOBBS and F. W. HOBBS, White Lake, S. D. The improvement is in bins as more especially constructed for holding nails and such like hardware, but also adapted as a convenient means for carrying various other kinds of merchandise. The bin embodies one or more tilting pockets which are readily accessible and may be lifted from their seats for cleaning, refilling, and other purposes.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

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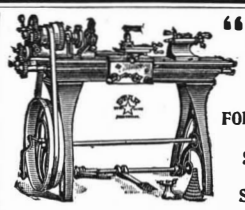

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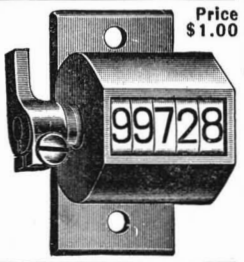

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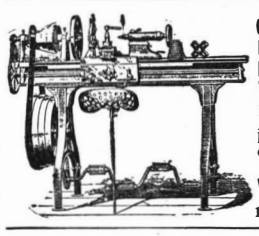

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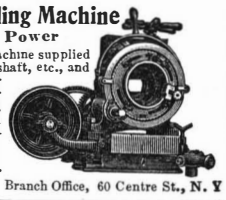

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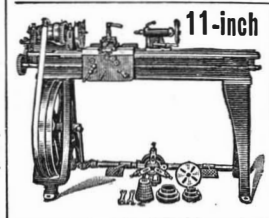

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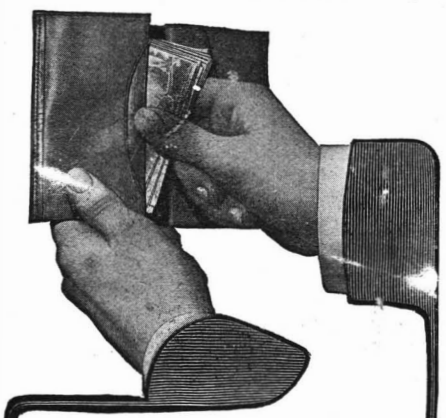

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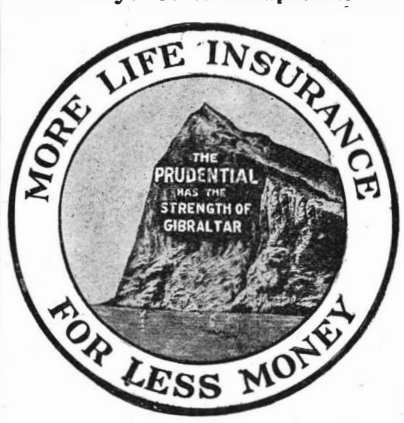

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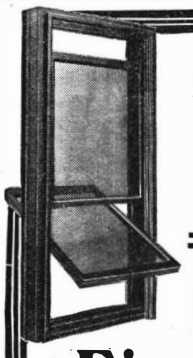

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Inquiry No. 8666.—Wanted to buy screw making machinery.

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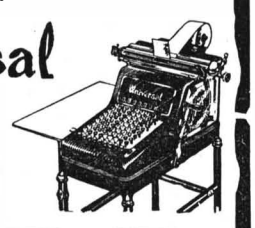

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Register or grill, A. B. Wenink 39,421
Spoon, fork, or similar article, C. W. Malmquist 39,415
Stove, H. G. Culter 39,422
Stove, Kennedy & King 39,423, 39,424
Watch fob, R. J. Stokes 39,414

TRADE MARKS.

Bed comforts, Carson, Pirie, Scott & Co..... 69,877
Beer and ale, H. C. Henking Co..... 69,887
Blue, wash and laundry, Halsey J. Tibbals Chemical Manufacturing Co. 69,885
Boilers for heating purposes, steam and hot water, Phelps Brothers Co..... 69,917
Bridges, rolling lift or bascule, Scherzer Rolling Lift Bridge Co. 69,898
Butter, eggs, and dressed poultry, United States Packing Co. of New Jersey..... 69,862
Canned fruits and vegetables, Griffith-Durney Co. 69,846
Canned salmon, Griffith-Durney Co..... 69,847
Canned salmon, North Alaska Salmon Co., 69,849, 69,857, 69,893
Carriages, carts, buggies, and wagons, Speedwell Motor Car Co..... 69,870
Coaster, wheel, Brownell Specialty Mfg. Co.. 69,865
Commutator polish, J. Goldmark 69,866, 69,867
Cotton cloth, J. Q. Gant 69,884
Currycombs, New York Stamping Co..... 69,915
Cutlery and tools, certain, J. A. Henckels, 69,919, 69,920
Electrical cables and conductors, certain, Standard Underground Cable Co..... 69,871
Electrical storage batteries, Vesta Accumulator Co. 69,872
Flour, wheat, Cowgill & Hill Milling Co.... 69,841
Flour, wheat, A. Thompson 69,860
Grit for poultry, Edge Hill Silica Rock Co.. 69,844
Gum, chewing, Wilson Chewing Gum Co.... 69,863
Hair remover, O. J. Harris 69,886
Horns or alarms, signal, Lovell-McConnell Manufacturing Co. 69,913
Igniting device and parts thereof, Auto Igniter Co. 69,907
Ironing boards and tables, Washburn & Wheeler Mfg. Co. 69,873
Knit silk and cotton gloves, Julius Kayser & Co. 69,911
Magazine, Kimball's Dairy Farmer Co..... 69,912
Magazine, monthly, E. Hubbard 69,910
Medicines, certain, P. Q. Medicine Co..... 69,894
Medicinal preparations, certain, W. E. McJohnston 69,892
Medicinal tonic, Theodore Metcalf Co..... 69,904
Molasses and sugar syrups, W. T. Reynolds & Co. 69,859
Musical instrument strings, M. E. Shoening.. 69,918
Oil, lubricating, Fiske Brothers Refining Co. 69,883
Ointment, C. E. Fulford, Ltd..... 69,876
Ointment, Patterson Medicine Co..... 69,895
Packing of metal, asbestos, rubber, and fabric, De Zouche, Hanson & Co..... 69,909
Paper and envelops, writing, G. B. Hurd & Co. 69,888, 69,889
Paper making material, United Railway & Trading Co. 69,861
Perfumes and toilet creams, Schieffelin & Co. 69,899
Phonographs, phonograph horns, etc., National Phonograph Co. 69,914
Piece goods, certain, J. Lonke 69,891
Pills, dyspepsia, D. J. A. Deane Co..... 69,881
Pins, hat, Otomobill Hat Pin Co..... 69,921
Plastic composition, synthetically prepared, Protal Co. 69,858
Potato meal, E. Klein Supply Co..... 69,843
Powder, gun, Hazard Powder Co..... 69,868
Remedy for certain diseases, Weiss Pharmacal Co. 69,905
Remedies for certain diseases, Southwestern Chemical Co. 69,902
Remedies for nervous maladies, H. Lamarque & Co. 69,890
Roofing and flooring composition, Standard Paint Co. 69,903
Rugs, carpets, and curtains, B. G. Casbarian 69,878
Sewing machines and attachments, Singer Manufacturing Co. 69,900, 69,901
Sheet metal ware, stamped, Central Stamping Co. 69,879
Smokers' articles, certain, Adolph Frankan & Co. 69,874
Soap, perfumed, David Brown & Son 69,842
Soap, toilet, R. C. Morrison 69,848
Steam fittings and supplies, certain, American District Steam Co..... 69,875
Steel bars, sheets, and plates, Colonial Steel Co. 69,880
Straw cleansing compound, M. J. Bebb..... 69,908
Tea, Grand Union Tea Co..... 69,845
Tents, Abercrombie & Fitch Co..... 69,864
Tooth paste, Reynolds & Lehr 69,897
Valves, Phelps Brothers Co..... 69,896
Wagon end gates, farm, Litchfield Mfg. Co.. 69,869
Whips, buggy and team, Norvell Shapleigh Hardware Co. 69,916
Woolen, silk, linen, and cotton piece goods, T. Elss 69,882
Wringers, rubber roll clothes, American Wringer Co. 69,906

LABELS.

"Bob Yokum's Buffalo Whiskey," for straight whisky, R. L. Yokum 14,283
"Bob Yokum's Buffalo Whiskey," for blended whisky, R. L. Yokum 14,284
"Cigarros Finos," for cigars, American Lithographic Co. 14,280
"Kenton Perfection Coffee," for coffee, Kenton Baking Powder Co..... 14,285
"Leon De Lis A," for cigars, American Lithographic Co. 14,281
"Penn," for beer, Consumers Brewing Co.... 14,282
"Perplexity Puzzle," for puzzle, M. H. Richardson 14,287
"Perspirine," for a remedy for excessive perspiration and for odors arising from the skin, H. H. Lepper 14,286

PRINTS.

"Circulating," for books of fiction, New Fiction Library 2,322
"Never Will Scratch," for a scouring soap, Bon Ami Co. 2,320, 2,321

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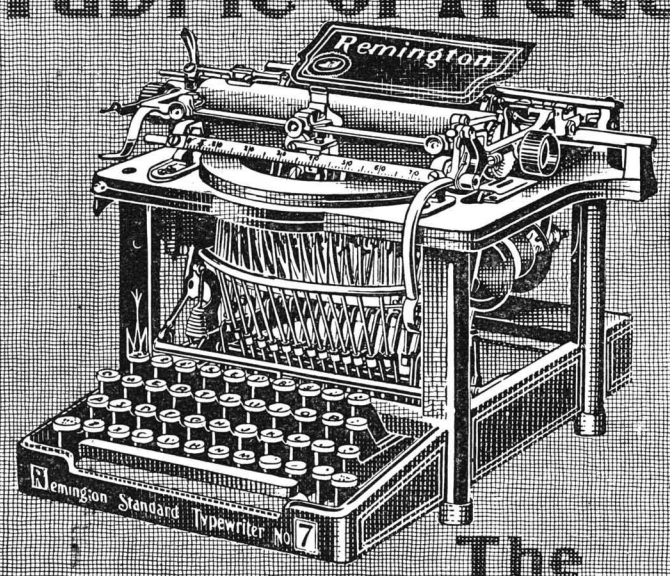

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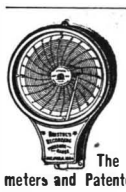

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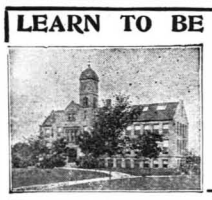

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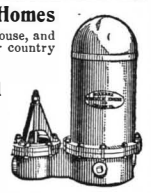

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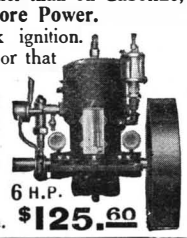

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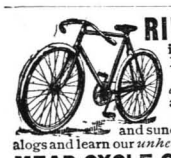

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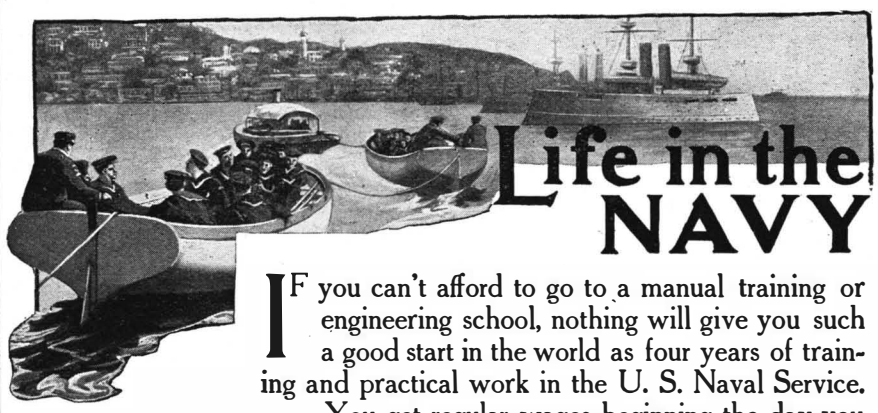

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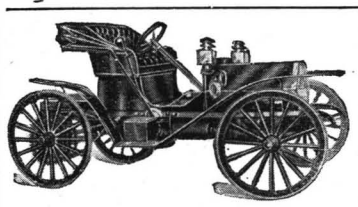

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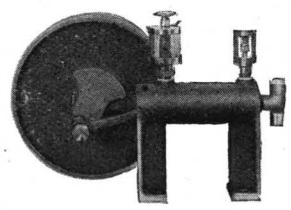

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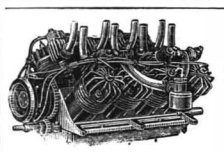

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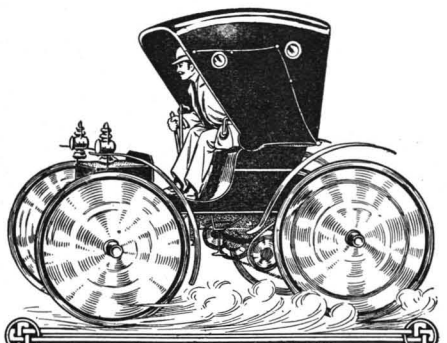

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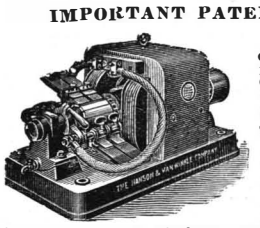

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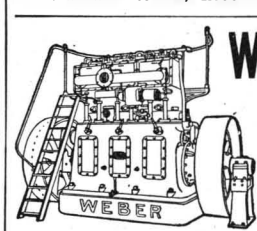

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